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ABSTRACT

This manual emphasizes the health relationships in the physical school environment and provides environmental criteria by which existing or planned facilities can be evaluated. Individual chapters deal with school health programs; planning for new schools; school site selection, building plan, and plan review; water supply; plumbing; sewage disposal; food service facilities and operation; illumination; thermal environment; acoustics; injury control; solid waste management; anthropod and rodent control; general housekeeping and maintenance. Appendix A lists publications on state guidelines and regulations. Appendix B offers recommendations concerning design of buildings for energy savings. Appendix C gives the American National Standards Institute specifications for making buildings accessible to the physically handicapped. This manual should prove useful to all persons concerned with providing healthful schools, including parents, teachers, administrators, planners, and health service workers. (Author/LD)

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HEALTH AND SAFETY IN THE SCHOOL ENVIRONMENT

A Manual of Recommended Practice

September 1978

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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Foreword

Health and Safety in the School Environment – A Manual of Recommended Practice is a revision of the former *Environmental Engineering in the School Environment – A Manual of Recommended Practice – 1961*. This publication emphasizes the health relationships in the physical environment and provides basic environmental criteria by which existing or planned facilities can be evaluated.

When necessary, additional guidance should be obtained to insure that the special needs of handicapped students are given due consideration. In this regard, standards such as those prepared by The American National Standards Institute (ANSI), Inc., should be consulted. The applicable sections of the ANSI standard which pertain to making buildings and facilities accessible to, and usable by, the physically handicapped are listed in Appendix C. Additional references on this subject are also provided.

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Chapter 1
INTRODUCTION

This manual provides a concise updated review of the health related aspects of the school environment. As you know, a document this size cannot afford an in-depth treatment of the complex environmental health field, but the reference list included will give ample opportunity for further study if the need arises. All persons concerned or involved with the provision of healthful schools, including parents, teachers, administrators, planners, and health service workers, should find this manual useful.

Between the ages of 5 and 18, the average person in the United States spends 180 days in school every year. Since this amounts to nearly one quarter of an individual's waking time during the 13 school years, the school environment is of tremendous importance. The school can be a healthful, comfortable place that enhances well-being and learning, or it can be a place that is hazardous to life and hinders the learning process.

The term "environment" includes three aspects (physical, biological, and social) that operate simultaneously and must be considered. These three aspects comprise the "total" school environment. In practice they are intimately related and, in fact, only artificially separated. In the school setting the physical environment includes the building and grounds, temperature, light, sound, furniture, facilities and equipment, air, water, and food. The biological environment includes plants, animals, insects, and microorganisms. The social environment includes the action and interaction of people: students, teachers, staff, and parents. Obviously, the conditions of any one aspect of the environment affect both of the other aspects.

This manual will discuss the physical aspects of the school environment more than the biological or social. However, it is imperative that the user be alert to the interrelatedness of the total environment and always concerned with consequences.

There are so many good reasons why school environments should be optimum for well-being and learning that there can reasonably be no other choice for a rational society. Specific reasons will be detailed in the chapters that follow, but four general reasons are:

1. Between the ages of 5 and 18 the individual develops from early childhood to adult status. The habits formed and attitudes gained during this time usually persist throughout life.

2. Diseases can be transmitted via adverse environmental factors, and these can largely be prevented.

3. An acceptable, clean, comfortable environment enhances teacher effectiveness, student learning, and the morale of all.

4. Accidents are the "unintended consequences of an unsafe act," and these events can be prevented through environmental, curricular, and behavioral control in the school.

The magnitude of the job of managing school environments is probably not widely appreciated. As an indication of the population affected, in 1976 there were 49,335,000 persons enrolled in pre-college schools (K-12) in the United States or 25 percent of the total population. There were 2,443,000 teachers in the system in 1975. The investment of $83,801,000,000 in 1976 for schools indicates a high level of general support, but even with this expenditure there are environmental and school health problems to be met.

In order that a school program may be effective, many people must share responsibility. The administrators (i.e., superintendents and principals), as the leaders in education and the responsible persons in the school district, are key figures in the development and maintenance of a healthful school environment. The administrator's knowledge, skill, support, and effective participation influence the success of the program. The recognition of this fact prompted North Carolina to develop a school environmental health regulation* which assigns responsibility for a monthly report from the principals to the superintendent on the environmental status in their schools. It is too early to evaluate the effectiveness of this procedure, but it does place responsibility for the periodic evaluation of environmental health programs where it logically should be.

Community understanding and cooperative support are also essential to all phases of the school program, including health and environment. Such understanding and support should be sought early in the preplanning stage.

**1974 Act to Provide Minimum Sanitation Standards for Public Schools* passed by the General Assembly of North Carolina, Chapter 1239, Section 2. "It shall be the duty of each principal to make an inspection each month of buildings in his charge and file written reports with the superintendent of his administrative unit, reporting conditions of cleanliness. . .and such other items and facilities as are necessary in the interest of public health. . .It shall be the duty of the principal to take immediate action to correct conditions. . . ."

Note: In Section 1 of this same Act, Health Department Sanitarians are also required to inspect each school at least annually to determine compliance with Health Service standards.

Chapter 2
SCHOOL HEALTH PROGRAMS

The environmental health concerns in the school are only a part, although a very important part, of a comprehensive school health program. While there is a wide variation in the quantity and quality of school health programs across the country, most activities fall into three generally accepted categories: (1) Healthful School Living – mainly environmental concerns; (2) School Health Services, and (3) Health Education.* All segments of the program are interrelated and interdependent.

School Health Services include those activities that aim at determination of the individual health status of students, teachers, and staff, referral for personal health services and corrective measures, and individual protective services, such as immunization programs and emergency first aid. Key persons involved are public health and school nurses, physicians, teachers, and school social workers. Typical activities conducted by these persons are compilation and maintenance of health records and history of students (year to year), multiphasic screening tests including vision, hearing, motor activity, general health evaluation, and occasionally dental and psychological evaluation.

As health problems are identified, the students are either involved in special programs (e.g., speech, hearing) or referred to corrective specialists, usually through contact or counseling with parents.

Since individual actions are often directly responsible for well-being or illness, one goal of health education is to teach students to be responsible for their own health. Students receive instruction in hygiene and anatomy, and they are also taught how personal decisions can affect their future health status. The use of alcohol, tobacco, and drugs, the importance of immunizations, and dietary habits are among the topics frequently taught. Ideally, a strong health education program would be one in which all persons — students, teachers, staff, and community — give health a high priority in their thoughts and actions, and each would be motivated to furnish examples through good health practices. Though Health Education has improved with advances in science and medicine, better teacher preparation and instructional methods are needed to reach this ideal.

We learn the English language from early infancy and through formal school programs, not only in the courses labeled "English," but in all courses. The same applies to "Reading." It is an element in every course. Health topics could also appropriately be included in many areas of study. History courses might include information on the major epidemics which impacted on human settlements, for example, plague, malaria, yellow fever, scurvy, and smallpox.

Social Studies could have units about the persons and agencies involved in the provision of health services, private and public, at the local, State, Federal, and international levels. In the upper grades, classes could collect data that would help them understand relationships between health status of communities, environmental factors, social factors, and health services.

Science studies provide an ideal place to learn function and dysfunction of the human body (health and disease), nutrition, the biology of diseases, and, above all, to learn about the ways in which man affects the environment and how it in turn affects man's health and well-being.

The list could be extended. However, these few examples will serve as a stimulus for further development in supplemental teaching.

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*For a more extensive review of School Health Programs see: A. Nemir and Warren E. Schaller, *The School Health Program*, 4th ed., W. B. Saunders Co., Philadelphia, 1975.

While related health topics in other subjects are desirable, they should be correlated with the health curriculum and should not be substituted for direct health instruction. A comprehensive School Health Education Program should include a planned, sequential series of health education instruction and experience in each grade level. Time allotments, according to The Society of State Directors of Health, Physical Education, and Recreation, should be:

1. In elementary schools, at least 2 hours per week of health instruction and other educational activities which are designed to promote valid health practices.
2. In middle or junior high schools, the equivalent of a daily period of direct health education for at least two semesters.
3. In senior high schools, the equivalent of a daily period of health education for at least two semesters, one of which may include drivers' education.

It was mentioned earlier that the environment of the school can serve as an example of good practice and thus be a learning experience which contributes to the development of attitudes, habits, and lifestyles which are compatible with optimum well-being. The administration, teachers, and staff are the key persons in the "Education" portion of the school health program. The public health physician, nurse, and sanitarian are the most essential health professionals on the school health team. However, the success of the program depends in large measure on the involvement and cooperation of the parents.

Chapter 3
PLANNING FOR NEW SCHOOLS

PUBLIC HEALTH RATIONALE

The planning and location of the school determine many of the environmental factors that may affect health. Input during plan development from a number of professional disciplines will insure the best possible school facility.

GENERAL

Early and adequate planning is essential. Therefore, one of the first steps in planning a new school is determination of need. This is usually done by the school administration and presented to the school board along with the appropriate justifications. Essential preliminary data includes a general estimate of numbers and levels of students, space needs, and area to be served. The school board, if it accepts the proposal, seeks finances for construction, assists with site selection, and contracts with the architectural and engineering firms for plan development.

Many States have adopted specific documents as planning guidelines to insure that adequate plants are designed (Appendix A). In addition to these guidelines, many States have either in the Department of Education or the Department of Health, a school plant specialist to assist local school systems with the alteration of existing schools or the construction of new buildings.

Persons involved in the planning process may come from several places in the community. They may include persons who are responsible for educational policy making or administration, persons in official agencies such as health departments and planning-zoning boards who are involved in consultation or evaluative roles, and persons from the community (including teachers) who serve on the planning committees. Education consultants, engineers, and architects retained by the school board are also involved in the planning phases. These groups must work closely together and communicate well in order to arrive at sound decisions and provide adequately for educational needs.

The following checklist is offered only as a starting point for concerned persons to derive their own timetable which fits the local situation. Legal requirements, special needs, and policies and procedures of State and local education departments must be properly phased into the timetable.

Suggested Checklist for New School Planning*

1. Make preliminary analysis of need by examining existing facilities, estimating future enrollment, and determining overall educational objectives and financial, social, economic or other restraints.
2. Organize public information effort to insure public support.
3. Select an architectural/engineering firm. (Since school design is a specialized activity, proven competence in these areas should be sought.)
4. Develop detailed "educational specifications" which serve as guide to the architect in designing the building. Specifications should be concerned with the types and numbers of programs and persons to be housed in the school, as well as space requirements, spatial relationships, equipment, and special environmental facilities.

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*Adapted from *Manual for Planning and Construction of School Buildings* 1975, State Department of Education, Concord, New Hampshire, p. 6.

5. Select a school site–this process is discussed in detail in Chapter 4.

6. Develop and review preliminary drawings (by local school board and State Department of Education usually, although a preliminary review by environmental health authorities would also be in order at this time).

7. Develop detailed specifications and drawings.

8. Secure funds for complete project.

9. Secure approval of plans from all State and local agencies. As a minimum, there should be health review of plans prior to seeking final approval from the State education authorities.

10. Prepare and award contracts for construction.

11. Review all phases of construction to determine compliance with plans.

12. Completion of the project (Figure 1).

The National Council on Schoolhouse Planning publishes the *Guide for Planning Educational Facilities*, which is available from:

Council of Educational Facility
Planners (new name)
29 West Woodruff Avenue
Columbus, Ohio 43210

The American Alliance for Health, Physical Education, and Recreation, 1201 16th Street, N.W., Washington, D.C. 20036, is an excellent source of additional publications. Additional planning assistance may be obtained from the Educational Facilities Laboratories, Inc., 850 Third Avenue, New York, N.Y. 10022.

Figure 1. A Completed School Facility

HIGH SCHOOL

Chapter 4
SCHOOL SITE SELECTION, BUILDING PLAN, AND PLAN REVIEW

SIZE OF SITE

The grounds around the school serve a number of purposes – from play space that children need for physical development to sports areas and parking areas (Figure 2). The following site sizes are recommended, but State regulations may vary and should be followed:

1. **Elementary Schools:** 10 acres plus one additional acre for each 100 pupils.
2. **Junior High Schools:** 25 acres plus one additional acre for each 100 pupils.
3. **Senior High Schools:** 35 acres plus one additional acre for each 100 pupils.

The recommended sizes should be viewed as flexible and probably optimum.

The size of the site for a new school should also be based on a careful projection of the total program and use of the proposed structure. For example, if it is to be a resource for the use of the community, space must be provided for this without diminishing the educational role of the facility.

ADDITIONAL CONSIDERATIONS REGARDING SITE

1. Topography of site should be suitable for use as play area, sports field, and parking area.
2. Services of electrical power, municipal water supply, and sewer systems should be available.
3. The site should be such that it is not likely to be affected adversely by future development in the area, such as industry or highway construction.
4. The site and area should be well drained and free from natural hazards, such as sharp drop-offs, or man-contrived hazards, such as those due to excessive traffic or harmful pollution (air, water, noise, radiation).

ACCESSIBILITY

1. The site should be easily accessible to the population to be served. Safe access should be provided for vehicles, bicycles, and pedestrians.
2. Suitable space for off-street loading and unloading of buses must be provided.
3. The accessibility of resources to students and staff should be considered. Such resources would include other educational institutions, libraries, museums, and natural areas for observation and study. Accessibility of school population to open spaces and pleasant surroundings is an asset to both teaching and learning.

SPECIFIC ENVIRONMENTAL HEALTH CONCERNS

While it is true that health is so broad in concept that all aspects of the environment impinge, there are some particular aspects of the environment that may have direct and dire effects on health. Some of these can be eliminated or minimized by proper site selection. Included in these are the following:

1. Provision for adequate, safe water supply and sewage disposal. Municipal services are recommended, but if not attainable, special clearances from environmental health authorities must be obtained for optional services.

2. Provision for solid waste management. Municipal services are recommended, but if not attainable, special clearances from environmental health authorities must be obtained for optional services.

3. Freedom from insect and rodent populations, for the prevention of both disease and nuisances.

4. The absence of excessive dust, smoke, odor, or other harmful air pollutants.

5. The potential for injury must be minimized. Hazards that may cause falls, burns, drownings, and traffic accidents need to be carefully evaluated.

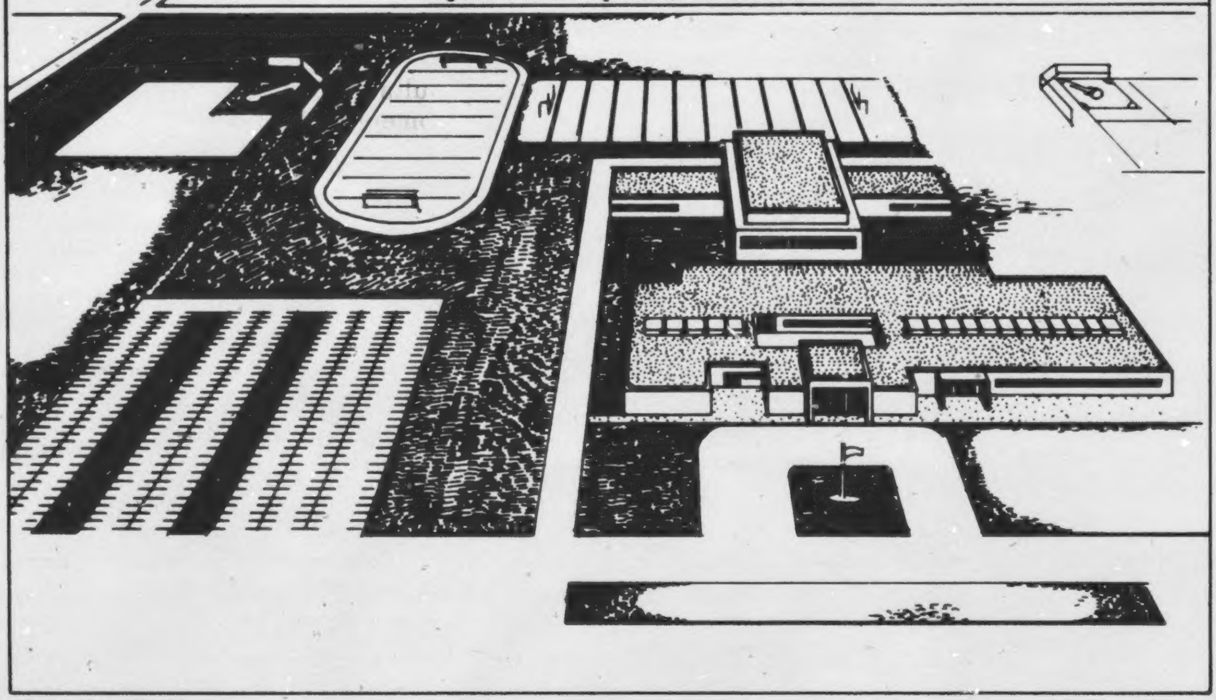
SITE SELECTION COMMITTEE

Site selection is obviously very important. The typical way of meeting this responsibility is to form a site selection committee to report to the school board the various alternatives and appropriate recommendations. The composition of the committee will vary, but facility planners, educators, environmentalists, students, and parents should be included.

BUILDING PLAN DEVELOPMENT

The actual building plan will be prepared by the architects with guidance from the school district and school planning authorities. There will usually be preliminary drawings of the floor plan which serve as "working drawings" to insure that the plant will meet the projected needs. Both education and health authorities

Figure 2. A Well-planned School Site



should review these preliminary plans. Prior to submission to the State education authority for final approval, the final plans and specifications should be reviewed and approved by the environmental health authority and any other agencies as required by law.

SPACE REQUIREMENTS

The following are a few of the more important space requirements from a public health standpoint:

1. Classrooms usually planned for occupancy by 25-30 students.
   a. **Elementary Schools:** 30 square feet per student with sink for hand washing near adjoining toilet facilities, especially for lower grades.
   b. **Secondary Schools:** 25-28 square feet per student with appropriate furnishings for subject to be taught. For example, science courses, because of the need for laboratory space, preparation areas, and demonstrations, may require up to 50 square feet per student.
2. Administration and teacher needs will vary, but as a minimum, office space for the principal and administrative staff, student guidance program, and conference rooms should be provided. Teachers should have office space, special preparation areas, and a lounge or relaxation area.
3. Special service areas, i.e., gymnasiums and auditoriums, should be provided to fit planned usage. Cafeteria and kitchen areas or a cafetorium are generally required and will be discussed in a following chapter.
4. Health service facilities should include an office for the school nurses, a waiting room, and an examination room with space for a cot and first aid equipment and supplies.

Space needs will vary depending on program, educational philosophy, and type and extent of community activities to be accommodated. Those in need of additional information may consult the references listed.

PLAN REVIEW

1. Many States have specific procedures established for plan review at the various stages of plan development.
2. The critical stages when input and consultation should be sought from local and State environmental health authorities are:
   a. Site selection process.
   b. Review of preliminary drawings.
   c. Review of final architect drawing and approval, prior to submission to State education authority for final approval.
   d. Consultation and inspection regarding equipment and fixtures for kitchen, toilet, rooms, gymnasiums, and swimming pools,* if planned. Consultation should be sought before, during, and after construction.

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*For a review of swimming pool safety, health, and operation, see: *Swimming Pools – Safety and Disease Control through Proper Design and Operation*, U.S. Department of Health, Education, and Welfare, Public Health Service, Center for Disease Control, HEW Publication No. (CDC) 76-8319, 1976.

Chapter 5
WATER SUPPLY

PUBLIC HEALTH RATIONALE

Consumption of water is essential to the physiological well-being of the human body. An ample supply of potable water is necessary for direct human consumption, personal hygiene, food preparation, and related services. Additional quantities are needed for fire protection, carriage of wastes, water operated or assisted physical facilities, janitorial services, landscape needs, and other special purposes. Contaminated water may be the vehicle for infectious organisms, toxic chemicals, or excessive radiation.

GENERAL

Each school must have an ample quantity of potable water that is protected from contamination at the source and throughout the distribution system. An adequate supply of water under pressure should be provided for new buildings, remodeled or altered old buildings, changed food service or other facilities, and increased classroom load.

All water supply lines in a school should contain potable water. However, in exceptional cases where adequate potable water may be scarce, provision may be made to obtain water for fire protection from non-potable sources if cross-connections do not exist between the potable and non-potable supplies. Such provision should be made only after all alternatives have been considered and in compliance with State and local codes.

Where potable water is not available and no treatable sources can be found, water may be transported to the school. This practice must be protected to the same degree and conform to the same standards of quality as piped public water systems. All transportation and distribution operations must be in compliance with recommendations of the local health authorities and under the control and supervision of responsible and informed personnel.

QUANTITY OF SUPPLIES

The minimum quantity of potable water which must be provided daily varies with the type of school and services provided. Recommended minimum quantities are shown in the table below:

Table 1. Potable Water Requirements – School Buildings

Type of School	Minimum Gallons Per Day Per Person
Day, without cafeteria, gymnasium, or showers	15
Day, with cafeteria but no gymnasium or showers	20
Day, with cafeteria, gymnasium, and showers	25
Boarding	75-100

In addition to these requirements, provision must be made for additional water for special needs. Estimates for shops, swimming pools, lawn watering, and operation of physical equipment should be prepared in consultation with the architectural/engineering firm or equipment supplier and added to the amounts calculated from the table. Also, the system should provide ample water under pressure during peak periods of demand such as the lunch hour and during the changing of classes.

SOURCES OF WATER

1. Public Supply

Under provisions of the Safe Drinking Water Act, Public Law 93-523, Section 1401(4), a "public water system" is any "system for the provision . . . of piped water for human consumption, if such system has at least fifteen service connections or regularly serves at least twenty-five individuals." (There is no distinction made as to whether the system is owned by a private concern or the public.) All schools are covered by this Act except those schools having their own supply and less than 25 students and staff.

Public Law 93-523 further defines two types of public water systems as "Non-Community Systems" and "Community Systems." Community systems are those which serve 25 **year-round residents**. Non-community systems serve the same minimum number of **individuals** as community systems, but the individuals are **not year-round residents**. Such a system would include those serving resorts, motels, hotels, and some schools.

Even though some school supplies may fall in the category of non-community systems, the recommendation of this manual is that all schools should attempt to meet the more stringent standards of the community water system. The justification is that the consumption of water at school during the year is similar to that of residents even though these individuals technically reside elsewhere.

If the school has access to a community water system operated by a municipality, water supply district, or private corporation, it will necessarily be regulated and monitored according to the provisions of Public Law 93-523, enacted December 16, 1974. In this case, the supply must conform to standards necessary to protect the consumer as established in the Act or the consumer must be so notified by the operator responsible for the system. It is recommended that all schools use a community water supply when feasible.

Where no community water system is available within a reasonable distance, it will be necessary for the school to construct its own system. Such a system, unless it serves less than 25 persons daily, will be regulated by the provisions of the Act as a non-community system. The construction of an individual water supply system depends upon the availability of water, free from contamination, in adequate quantity to supply the need. Planning for and building a private water supply requires the aid of a registered professional engineer competent in water supply system construction. At the very outset of the planning for such a system, the health department engineer or sanitarian should be consulted to advise the school board or principal of the requirements of the local health authority.

The details on construction of a satisfactory individual water supply are described in the U.S. Environmental Protection Agency *Manual of Individual Water Supply Systems* (EPA 430-9-73-003) available from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Since the descriptions in this manual are complete and detailed, they will not be repeated here. Similar publications or assistance on this subject may also be requested from the State health department.

2. Private Supplies

The Safe Drinking Water Act does not technically apply to those schools which construct their own supply and serve less than 25 individuals daily. Supplies serving schools in this category should follow the recommendations cited in the preceding paragraph. Such systems must comply with applicable State and local standards. In all cases the water should be monitored for microbiological quality and adhere to the microbiological standards required of public water supplies. Every effort should be made to provide water that is free from known toxic chemicals.

WATER QUALITY

The standards for drinking water quality and monitoring requirements of the Safe Drinking Water Act should be maintained.

1. Maximum Contaminant Levels – Inorganic Chemicals

For selected toxic chemicals, the Environmental Protection Agency has established maximum contaminant levels which apply to community water systems. Of these, only the level for nitrates applies to noncommunity water systems. The standards effective June 24, 1977, for various chemical contaminants are shown in the following tables:

Table 2. Maximum Contaminant Levels – Specified Chemicals*

Contaminant	Maximum Contaminant Level, milligrams/ℓ
Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.0
Selenium	0.01
Silver	0.05

*Inorganic chemicals other than fluoride

Fluoride maximum contaminant levels depend upon annual average maximum daily air temperature as shown in Table 3.

Table 3. Maximum Contaminant Levels – Fluorides

Temperature		Maximum Contaminant Level, milligrams/ℓ
F	C	
53.7 and below	12.0 and below	2.4
53.8 to 58.3	12.1 to 14.6	2.2
58.4 to 63.8	14.7 to 17.6	2.0
63.9 to 70.6	17.7 to 21.4	1.8
70.7 to 79.2	21.5 to 26.2	1.6
79.3 to 90.5	26.3 to 32.5	1.4

2. Maximum Contaminant Levels – Organic Chemicals

Although maximum contaminant levels for certain organic chemicals have been developed, these standards are under constant review and subject to revision and expansion of substances covered. It is, therefore, recommended that school authorities ascertain that the supply of water obtained meets the standards in effect during the actual service. The procedures necessary for monitoring for the presence of these substances are quite complex, and the responsible school authorities should rely on advice from the agency in each State that is responsible for enforcement of the Safe Drinking Water Act. New and revised standards are published in the *Federal Register*.

3. Maximum Contaminant Levels – Turbidity

Because turbidity may interfere with disinfection, it is recommended that the maximum monthly average turbidity not exceed one turbidity unit. Exceptions and allowable variations are published in the *Federal Register*, Vol. 40, No. 248, p. 59571, 1975.

4. Maximum Contaminant Level – Microbiological

All potable water supplies should be monitored for the presence of coliform bacteria as an index of the possibility of contamination by pathogenic microorganisms. The recommended standards vary with the monitoring procedures and the number of samples required for the system. Essentially the requirement is that not more than one coliform be found present in any 100 ml sample examined. Details on the variations and monitoring required appear in the *Federal Register* already cited. State and/or local codes should be reviewed for any additional requirements.

BACTERIOLOGICAL CONTROL

In those cases where an on-site water system is involved or where water may be transported, it will be necessary to provide a system for disinfection. At the present time, the most common method of disinfection is by the use of a chlorination system.* The Environmental Protection Agency *Manual of Individual Water Supply Systems* describes several methods of maintaining residual chlorine in the water supply and recommends good standard practices. This manual describes in detail methods for disinfection of wells and distribution systems. It is imperative to obtain the advice of health authorities before installing and operating a disinfection system.

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*Other means of chemical disinfection such as those involving ozone, iodine and bromine are currently being developed. It is incumbent upon school authorities to investigate these possibilities in cooperation with State and/or local health personnel.

Chapter 6
PLUMBING

PUBLIC HEALTH RATIONALE

Hot and cold water under pressure, flush toilets, and washrooms are necessary for personal hygiene in all schools. In those schools having food service operations, additional facilities are necessary for sanitary food preparation and cleaning procedures. Dressing rooms equipped with showers are required if students participate in physical education.

GENERAL

A properly designed plumbing system must maintain the supply of potable water under pressure while also protecting it from contamination. The water must be distributed through the building to a sufficient number of accessible, clean fixtures convenient for use. The sanitary sewerage system must function reliably to collect sewage and convey it in a sanitary manner to the treatment system. Plumbing fixtures must also be of sufficient number, proper design, and kept clean. Most states, school systems, or local agencies subscribe to a code of standard design and performance for plumbing systems. As with other design elements, the school authorities should seek the advice of appropriate professionals in determining what codes are applicable and subscribe to these provisions in the design of the plumbing system. There may be special State standards for the school that are more stringent than local codes which must be followed.

Some national agencies develop design standards that may be used in the absence of a local code. A list of these agencies appear at the end of this chapter.

FACILITIES

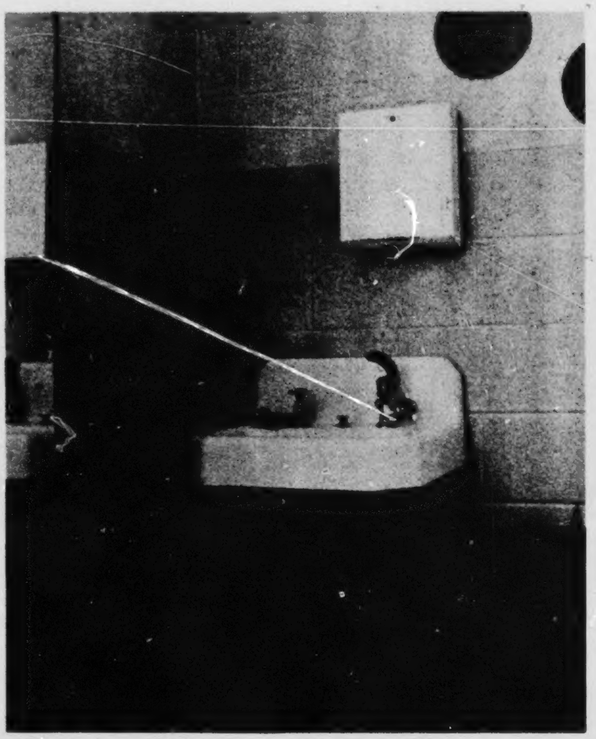
1. Lavatories

Lavatories should be conveniently located throughout the school plant. Lavatories should be located adjacent to cafeterias, in classrooms of lower grades in elementary schools, and in cafeteria-kitchen areas. State or local codes governing food service establishments must be followed for installation of lavatories in food service areas. Lavatories in toilet rooms should be placed so that students will pass them in leaving the room (Figure 3).

Table 4. Minimum Lavatory Facilities for Schools

Types of Schools	Fixture-to-Pupil Ratio
Elementary and Secondary Schools	1:30 pupils up to 300 pupils 1:40 pupils for all above 300

Figure 3. Handwashing Sink



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Each lavatory should have hot and cold water under pressure, towels, soap dispensers, and a receptacle for used towels.

If water under pressure is not available, other suitable handwashing facilities must be provided. Facilities should be placed in vestibules where they may be readily used by pupils after using the toilet. Tanks on stands may be improvised and should have water storage capability of not less than one-half gallon per pupil per day. Spring-type faucets limit flow and are essential under these circumstances. Wastes from the water basin or sink should be disposed of properly.

2. Water Closets

Water closets should be located in toilet rooms on each floor where classrooms are located. In recent years toilet facilities have been installed in each classroom for children 5 to 7 years of age. Where this is not done, toilet rooms should be separated for use by younger and older pupils. This may generally be accomplished by locating toilet rooms near the appropriate classrooms. In each toilet room for general use, not less than two water closets should be provided. Minimum water closet ratios beyond this are shown in the following table:

Table 5. Minimum Number of Water Closets for Schools

Types of Schools	Water Closets-to-Pupils Ratio	
	Boys	Girls
Elementary Schools	1:40	1:35
Secondary Schools	1:75	1:45

In rural areas where water under pressure is not available, the use of sanitary privies or chemical toilets may be permitted. These should be constructed in conformity with requirements of the State and local health department having jurisdiction.

3. Urinals

In each toilet room for males, water flush urinals should be provided in the ratio of one fixture to each 30 males for both elementary and secondary schools. In certain situations, local health authorities may permit the use of non-flush, trough-type urinals if the drainage is disposed of properly, and the troughs are kept clean by daily scrubbing with a disinfecting solution. In these situations, deodorant blocks available for use in public urinals may be helpful in reducing odor.

4. Showers

Every school with gymnasiums, organized athletic events or physical education classes should have shower facilities for each sex. Shower heads should be provided in the ratio of 1:5 pupils for the largest single gymnasium or swimming class to be anticipated.

5. Drinking Water Fountains

Sanitary drinking water fountains should be located at strategic locations. A minimum ratio of 1 to 100 pupils and 1 per floor is recommended.

6. Service Sinks

Service sinks which have hot and cold water should be provided on each floor convenient to locker rooms, shower rooms, toilet rooms, cafeterias, and kitchens. The water outlet to the service sink should be a combination which has a mixture of hot and cold water and is equipped with a hose bib. Each combination faucet should have an approved vacuum breaker.

7. Facilities for the Handicapped

The Rehabilitation Act of 1973 requires that handicapped persons not be excluded by reason of their handicap from participation in programs that receive Federal assistance. Many states have enacted more stringent requirements than are contained in this Act. Consideration should be given to the needs of the handicapped in the use of the sanitary facilities.

Specifications for plumbing and building standards for the handicapped are given in American National Standards Institute document ANSI A1171-1961 revised 1971, or later revisions. The applicable sections of this standard are shown in Appendix C.

CROSS-CONNECTIONS

The potable water supply should never be connected to any fixture or device that could permit contaminated water to be forced or sucked into the potable system. Special attention should be given that hoses are not connected in laboratories, at service sinks, or elsewhere, or allowed to hang down into wash basins or sinks where contaminated liquids may be contained. A variety of vacuum breakers and backflow preventers are available and should be installed in accordance with applicable plumbing codes.

MAINTENANCE

Toilets and handwashing facilities cannot be properly used if allowed to become dirty, clogged, and odorous. Each toilet room should be cleaned at least daily and all supplies checked and replenished. More frequent cleaning may be necessary in areas of heavy usage.

A schedule should be established for periodic inspection of the school plant during the day as determined by actual need. It is useful to have a schedule of such inspections posted in a place accessible to the janitorial staff and the appropriate supervisory personnel. When the task is completed, the schedule should be initialed by the person doing the work. During these inspections, water faucets and water fountains should be checked for leaks. Signs posted in restrooms encouraging handwashing and requesting that deficiencies and unclean conditions be reported may be useful.

The use of deodorant blocks in urinals is acceptable. However, the best means of odor control is frequent cleaning and disinfection. It is not acceptable to substitute the use of deodorants for cleaning. All supplies, disinfectants, and cleaning tools should be kept in a locked area which is not accessible to students or other unauthorized persons.

Agencies Providing Codes or Design Standards:

1. American National Standards Institute, Inc.
   1430 Broadway, New York, New York 10018

2. American Society of Sanitary Engineering
   228 Standard Building
   Cleveland, Ohio 44013

3. American Water Works Association
   Two Park Avenue
   New York, New York 10016

4. National Sanitation Foundation
   NSF Building
   Ann Arbor, Michigan 48105

5. National Automatic Merchandising Association, sponsor of Automatic Merchandising Health Industry Council
   7 South Dearborn St.
   Chicago, Illinois 60603

Chapter 7
SEWAGE DISPOSAL

PUBLIC HEALTH RATIONALE

Body wastes are a main link in the transmission of disease from one person to another. It is, therefore, of prime importance that adequate disposal measures be instituted to control this avenue of disease dissemination. If they are not subjected to approved disposal measures, wastewaters from food service operations, janitorial services, laboratories, pools, showers, handwashing, and other school activities may attract vermin, putrefy, cause noxious odors, and serve as breeding places for insects.

GENERAL

All liquid wastes should be handled in a sanitary manner. The same system for disposal of body wastes may be used for disposal of wastewaters generated from other school activities. This system must be watertight, vented outside the building, and connected to all waste collection receptacles (toilets, sinks, etc.) by a water trap that prevents gas exchange within the building. The integrity of this system must be maintained so that there is no possibility of leakage and no direct connections are made between this system and the water supply.

PUBLIC SEWER SYSTEMS

Proximity of the school site to a public sewer system should be carefully investigated prior to any site selection. Authorities concerned with this feature of a community's service systems include the Department of Public Works and the Health Department. The Health Department has general jurisdiction over most health matters, and its advice should be sought early in the planning stages. If the public sewer system is not proximate to the school site, but plans exist for extension of the system to or near the school site at a later date, use of an interim treatment plant on the school grounds with means for future connection to the public sewer system should be considered.

The planning of a sewer system to collect, transport, and treat sewage is quite complex and must comply with many State and Federal standards. The financing of such systems often involves long-range planning and coordination of efforts between local, State, and Federal agencies. Therefore, school authorities should contact the agencies in charge of developing the public sewer system at the earliest possible time. The long-range plans for development of school facilities should be submitted to the sewer planning agency with a request for coordination of effort. This should provide long-range savings of time and money and a much preferred system of waste disposal.

PRIVATE OR INSTITUTIONAL SYSTEM

Where access to public sewer system is not possible, an alternate means of disposal must be devised. Decisions concerning planning of the school, the layout and design of the buildings, the selection of playground areas, and even the selection of the site itself are contingent upon the disposal method chosen. Early consultation with the appropriate regulatory agencies is essential.

It is not the purpose of this manual to outline all of the design criteria for disposal of wastewater. However, it may be of some use to outline some of the basic options and restrictions involved.

Wastewaters may be disposed of in two basic ways: They may be applied to the soil or discharged into surface waters. Both systems have limitations and both require some degree of pretreatment.

1. Soil Application

The disposal of wastewaters by soil application depends upon the availability of suitable soils to receive the wastes. Evaluation of soils for the capacity to absorb wastes will require a variety of soil test procedures and a study of the rainfall distribution and surface hydrology.

The method of application of wastes is also a factor. The most common method is subsurface disposal following pre-treatment in a septic tank. Subsurface disposal may also follow more complex methods of aerobic treatment in any one of a wide variety of treatment packages. An alternative method to subsurface soil application is a system of distribution to the soil surface. For most schools the potential for problems with flooding, possible pathogen dispersal through aerosols, and the need to utilize all available land would preclude this alternative.

It is possible that rural schools or schools with an agricultural program could utilize their wastewaters as a supplement to agricultural soils through surface application.

The use of percolation tests for the determination of soil suitability is recommended. However, many regulatory agencies have greater success using soil analysis and soil mapping techniques. An excellent reference to this improved method and to waste disposal alternatives is the book *Wastewater Treatment Systems for Rural Communities*, published by the Commission on Rural Water, 1820 Jefferson Place, N.W., Washington, D.C. 20036, 1973.

2. Discharge to Surface Waters

Wastewaters may be discarded into lakes and streams following treatment. The degree of treatment necessary before discharge depends upon many factors. The nature of the receiving waters is of prime importance. The assimilative capacity of the receiving waters depends upon the volume, flow, temperature, and a number of other characteristics. It is also important to consider how the receiving waters are used following the discharge of wastes into them.

There are many systems available for treatment of wastewater prior to discharge. Most often the systems used by schools will be some type of package treatment plant selected from a number of commercial designs. These systems usually provide for odor-free, aerobic digestion of organic materials in the water followed by clarification, disinfection, and filtration when necessary. In some cases, nutrient removal may be required before the final discharge of the treated water.

Selection of an effective and economical system must be made in consultation with the controlling State and/or local health agency.

MAINTENANCE

No system of waste treatment and disposal can operate properly without maintenance. Grease traps and septic tanks require routine cleaning. The grease trap will need service more often than the septic tank and is probably handled best by the school maintenance staff. A septic tank cleaning schedule should be based on need as determined by frequent inspections. A responsible person on the staff should be designated to see that the scheduled cleaning is performed. The grease removed should be disposed of through the regular solid waste management system of the school. Septic tanks require inspection and cleaning as sludge and scum accumulate in the tank. Such service is usually best performed through a contract with a commerical waste disposal service.

Package waste treatment systems require frequent inspection, monitoring, and maintenance. These may be provided by a service contract with the commerical concern that installs the system. Occasionally, a member of the maintenance staff may be designated to service the system, providing the school insures adequate training. He may be required to attend a training school or sessions provided by the system supplier.

If there is a turnover of personnel, additional training funds may be required. It is poor economics to pay for a waste treatment system and not provide instruction for the personnel in charge of its operation.

LEGAL REQUIREMENTS

Sewage disposal systems must comply with many types of legal requirements designed to protect the public health and the property of others and to maintain a healthy environment. Local plumbing ordinances or State school standards and enforcement may vary so that it is important to check with all regulatory agencies. Additionally, local zoning requirements concerning waste disposal plants may require extensive land acquisition for maintaining required separation distances from housing. Such requirements should be considered early in the school site planning. If the discharge is to surface waters or involves land application, the facility may also have to meet the requirements of the State or Federal agency charged with administration of the Water Pollution Control Act (Public Law 92-500).

Chapter 8
FOOD SERVICE FACILITIES AND OPERATION

PUBLIC HEALTH RATIONALE

School and health authorities must insure the maintenance of exemplary standards of hygiene in food service programs to prevent illnesses transmitted through food. Food sanitation in the school lunch program is particularly important because the food is prepared for service to a relatively large number of students, all of whom would be subject to illness if the foods were not safe and wholesome. A clean kitchen and dining room will contribute not only to the wholesomeness of the food but to better nutrition by enhancing its palatability. The aesthetics of the lunchroom (color, decor, etc.) can have positive effects on digestion, behavior, and attitudes about food. Also, a clean, properly operated food service provides students with an example from which to learn.

FOODBORNE DISEASES

Of the many organisms that can be foodborne, the most common are *Staphylococcus aureus*, *Salmonella*, and *Clostridium perfringens*. Foodborne illnesses are usually not fatal, but cause much discomfort, temporary disability, and loss of school time. The possibility of more serious communicable diseases or serious chemical poisoning also exists and must be guarded against. The need for concern is exemplified by the 24 outbreaks and 3677 cases of foodborne disease in schools reported during 1976. This is estimated to represent a small portion of the total number of reported illnesses due to the ingestion of contaminated food.

Although a variety of foods can serve as a vehicle for transmitting foodborne illness when improperly handled, those that consist in whole or in part of milk or milk products, eggs, meat, poultry, fish, shellfish, or other ingredients capable of supporting rapid and progressive growth of infectious or toxigenic microorganisms are most often incriminated. These foods are referred to as the "potentially hazardous foods." Turkey in particular has been found to be the most commonly reported vehicle causing foodborne illness in schools. Raw turkeys are frequently contaminated with *Salmonella*, *Staphylococcus aureus*, and *Clostridium perfringens* organisms. Because turkeys are usually cooked a day or more in advance of serving, failure to promptly and adequately refrigerate cooked turkey stock and dressing creates conditions favorable for bacterial growth, thus contributing significantly to the foodborne disease potential. These products must be adequately reheated to 165°F (not just warmed) before serving to destroy any bacteria that multiplied during storage.

SATISFACTORY PRACTICE

1. General

Responsibility for regulation and control of the school food service program rests with the principal. The principal may appoint a director of the school cafeteria who will manage the operation. It is necessary that this person, and all food service workers, understand and practice the principles of good sanitation and safety. Special emphasis should be placed on the prevention of those factors that have been shown to contribute to foodborne outbreaks. These factors include: inadequate cooling, inadequate hot storage, infected persons handling food, foods prepared a day or more before serving and using leftovers, inadequate reheating, inadequate cleaning of equipment, cross contamination, inadequate cooking, use of toxic containers, contaminated raw ingredients, intentional additives, accidental additives, and obtaining food from unsafe sources.

The enforcement of environmental health

standards is one function of local health departments. Most local departments have food establishment codes or ordinances that cover school kitchens and cafeterias, insuring that food service areas will be inspected routinely. Compliance with these codes should receive high priority from school authorities.

2. Personnel

People are the most important aspect of clean, healthful food service. It is essential that food service personnel employed by the school be properly trained. Sanitarians in local health departments can be contacted for information and instruction.

Disease transmission through food frequently originates from an infected food handler. A wide range of communicable diseases and infections can be transmitted by these individuals to other employees and consumers through contaminated foods and careless food handling practices. Boils, infected cuts, and pimples are important sources of organisms which cause staphylococcal food intoxication, one of the most frequently reported types of foodborne disease in the United States. The nose and skin, without lesions, are also sources of these organisms; thus, personal hygiene is very important. In addition, the intestinal tract is a common source of *Clostridium perfringens* organisms which might contaminate food products.

No person should be allowed to work in the school kitchen while infected with a disease that can be transmitted by foods, or who is a carrier of organisms that cause such a disease, or while afflicted with a boil, an infected wound, or an acute respiratory infection.

Handwashing and personal hygiene are of critical importance to sanitary food service. Hands are probably the most common vehicle for the transfer of contamination to food. Hands should be washed at frequent intervals and always after use of toilet, touching raw meat or poultry, coughing, sneezing, smoking, eating, touching sores, pimples, and the nose. Also, hands should be washed before beginning work initially and before resuming work after breaks. Clean clothing should also be worn by food service workers at all times in the kitchen.

3. Food Protection

It is essential that all food consumed on the school premises have adequate protection. Local and State health regulations will detail specific standards regarding food care. The following list summarizes some of the more important aspects of food preparation:

a. Food service personnel in schools should insure the use of wholesome foods from approved sources. Of special concerns are all dairy products, eggs, poultry, meat, fish, and shellfish.

b. While being stored, prepared, displayed, served, or transported, food must be protected from contamination by dust, insects, rodents, unclean equipment and utensils, unnecessary handling, draining and overhead leakage or condensation.

c. Potentially hazardous food must be kept hot (over 140°F) or kept cold (below 45°F) to prevent microbial growth. Hot foods should be cooled rapidly to minimize the time they remain within the danger zone (45°F to 140°F). The following procedures will facilitate rapid cooling of potentially hazardous foods:

   (1) Do not allow hot foods to cool at room temperature before refrigerating.

   (2) Do not store foods at room temperature.

   (3) Store food in shallow containers in the refrigerator to accelerate the cooling process.

   (4) Insure that the refrigeration unit is functioning properly (45°F or below).

d. Milk provided by the school should be Grade A pasteurized, and kept refrigerated at 45°F or below. Milk which is served in its original container or from an approved bulk milk dispenser is less likely to become contaminated.

e. Food should be prepared with the least possible manual contact, with suitable utensils, and on surfaces that prior to use have been cleaned, rinsed, and sanitized. The time between preparation and serving should be as short as possible.

f. Cross-contamination of food must be prevented. Since raw foods of animal origin may be contaminated, they should be kept separate from prepared foods, and utensils and equipment used for raw foods should not be used on prepared foods unless thoroughly washed, rinsed, and sanitized before use.

g. Rodents and insects must be controlled because they may carry disease-producing organisms on their feet, bodies, and in their intestinal tracts.

4. Cleaning and Sanitization

The effective cleaning and sanitizing of equipment, utensils, and work surfaces minimize the chances that food will become contaminated during preparation or storage; that food residues will accumulate, decompose, or support the rapid development of food poisoning organisms and toxins; and that disease organisms will be transferred to consumers. The cleaning operation should be adequate to clean and sanitize the volume of dishes and utensils generated during peak periods, and to clean and sanitize storage containers, cutting boards, knives, slicers and other equipment, as necessary. Cleaning and sanitizing dishes and utensils can be done manually in a three-compartment sink (wash, rinse, sanitize) or mechanically in approved dishwashing machines (Figure 4, 5). Single-use articles (paper

Figure 4. Three-compartment Sink

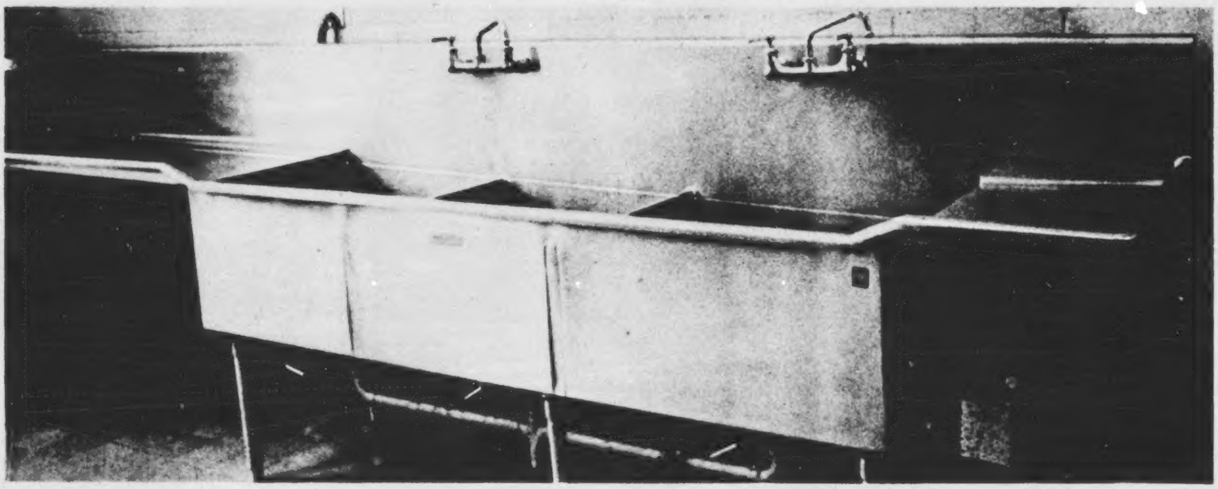
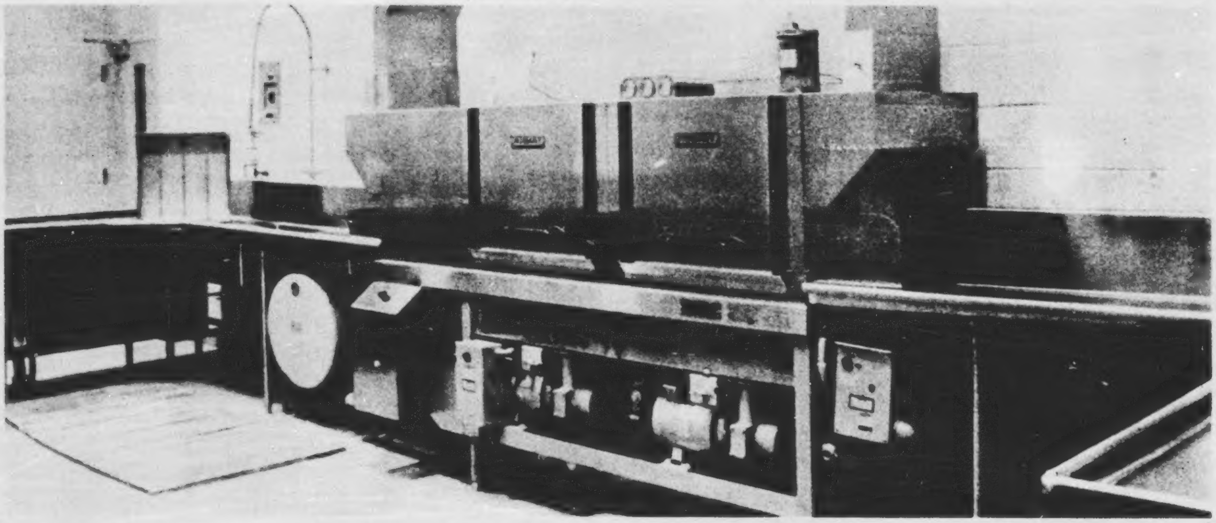


Figure 5. Dishwashing Machine

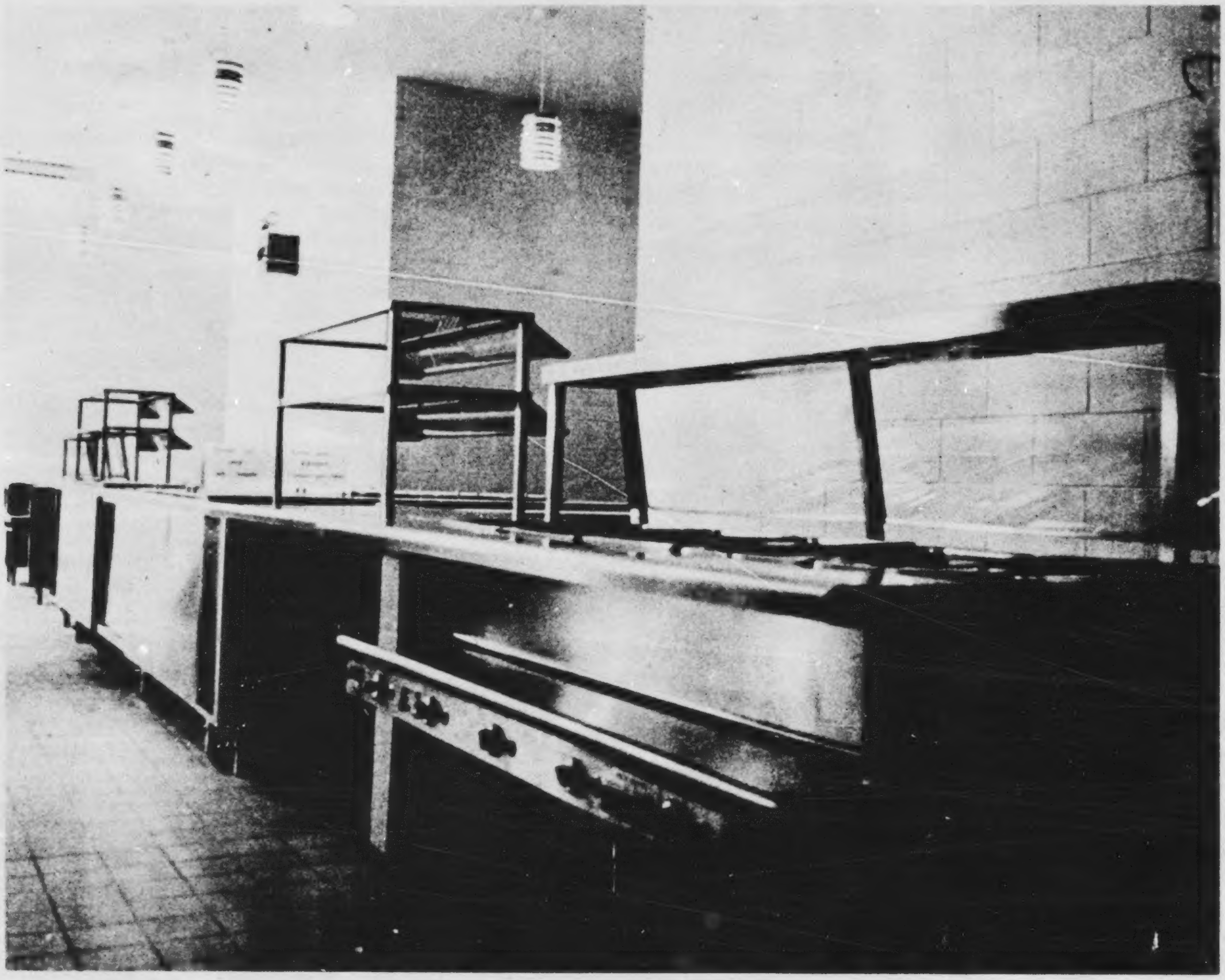


or plastic plates, cups, or utensils) should be used where adequate cleaning and sanitizing of multi-use utensils are not practical. Tableware, kitchenware, and food contact surfaces of equipment should be cleaned and sanitized after each use and following any interruption of operations that might permit contamination. The food contact surfaces of grills, griddles, and similar cooking devices and the cavities of microwave ovens should be cleaned at least once a day and should be kept free of encrusted grease deposits and other accumulated soil. Non-food contact surfaces of equipment should be cleaned as often as is necessary to keep the equipment free of accumulation of dust, dirt, food particles, and other debris.

5. Size and Layout of Cafeteria, Dining Rooms, and Kitchen

The size of a cafeteria dining room will vary, of course, with the number of students, type of program, and planned use of cafeteria (alternating use as gymnasium or auditorium, for example). Unless other guidelines or considerations intervene, it is acceptable to plan 11 ± 2 square feet per lunch served each day for the cafeteria, and 6 ± 0.5 square feet per lunch served per day for the kitchen.

Figure 6. Double-line Food Serving Facility



Aisles and working spaces between units of equipment and between equipment and walls should be unobstructed and of sufficient width to permit employees to perform their duties readily without contamination of food or food-contact surfaces by clothing or personal contact. Sufficient space should be provided for easy cleaning behind and between each unit of floor mounted equipment, or these spaces should be closed to prevent contamination.

Kitchen layout is a highly specialized function. Therefore, the plans should be checked at all phases of the project by a qualified individual.

6. Kitchen Equipment and Facilities

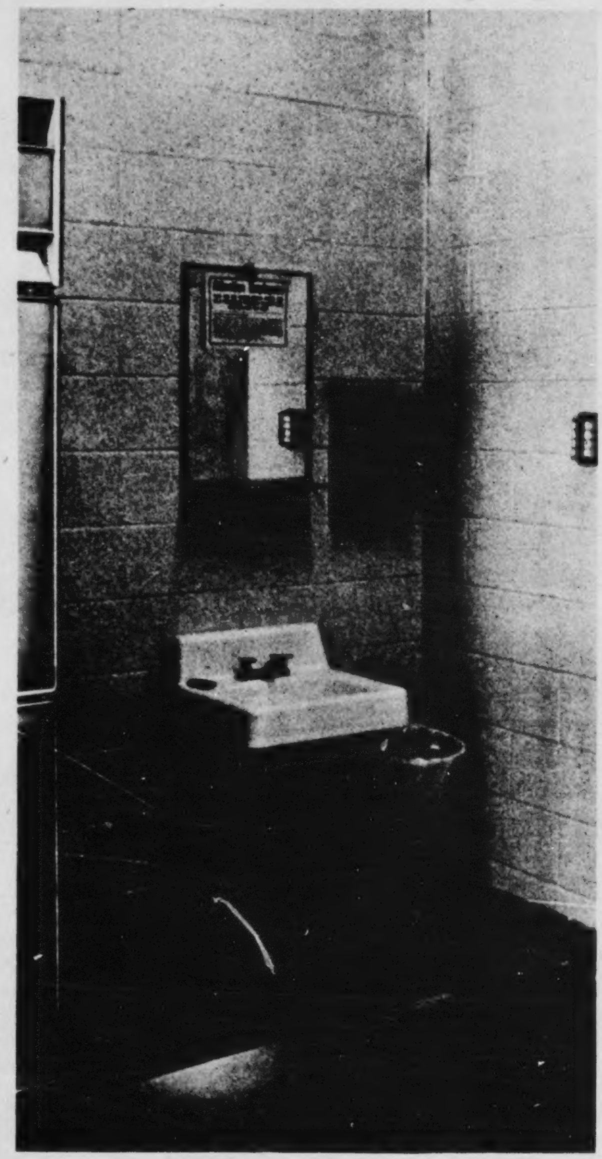
The need for equipment will vary with the number of persons to be served. However, each kitchen will include basic equipment for: refrigeration, dry storage, hot storage, vegetable and meat preparation, dishwashing, cooking, baking, ventilation, and food serving (Figure 6).

Every food service facility should have an adequate supply of hot and cold potable water under pressure, adequate plumbing, toilet facilities, ventilation, lighting, and a comprehensive solid waste management system. These subjects are discussed in more detail in other chapters. Adequate handwashing facilities (lavatory, soap, hand towels) must be provided in the kitchen area at convenient locations (Figure 7).

Floors, walls, and equipment should be maintained in good repair and kept clean. Floors should be finished so as to facilitate cleaning and to prevent the absorption of grease or other organic material. Properly installed floor drains are needed to carry away spills or fluid wastes. To facilitate cleaning, non-absorbant materials should be used in wall areas from the floor to the height reached by splash or spray. Local and State environmental health regulations give additional information about equipment and facilities.

For additional information about regulations on food service operations, consult the latest version of the *Food Service Sanitation Manual* published by the Food and Drug Administration.

Figure 7. Handwashing Facility



Chapter 9
ILLUMINATION

PUBLIC HEALTH RATIONALE

A well-lighted environment conserves eyesight, discourages unsanitary conditions, and may contribute to learning efficiency. In addition, good lighting will help provide a greater sense of well-being and comfort.

GENERAL

Much has been published on the subject of light — what it is, how it is generated, the mechanics of seeing, and similar information. The material contained in this chapter will pertain to the principles of lighting as applied to vision tasks in schools and how proper school lighting may be measured and obtained.

Proper lighting embraces two concepts, quantity and quality. An abundance of light may not necessarily mean that proper lighting is achieved. A basic principle in lighting science is good light distribution. As in the case of acoustics, the design and application of light fixtures is a highly developed science. Therefore, the services of an illumination engineer or architect experienced in illumination practice will be valuable. However, those concerned with school planning and maintenance should be aware of the general facts concerning proper lighting and the methods whereby it may be achieved. The school science teacher or principal using a light meter can tell a great deal about existing light environments and can make recommendations for improvement.

LIGHTING TERMINOLOGY

There are a few units commonly used in the design and evaluation of illuminated spaces which should be known by school personnel dealing with these problems. They are as follows:

1. Lumen

The lumen is the unit used to measure the amount or quantity of light output from a light source. A light source of one candela (formerly "candle") produces 4π lumens.

2. Footcandle

The footcandle is one unit of illumination. It is a measure of the amount or quantity of light falling on a unit area. If, for example, 1 lumen from a light source falls on 1 square foot of a surface, the illumination would be 1 footcandle. Also, a surface 1 foot from a source with an intensity of 1 candela would have an illumination of 1 footcandle.

3. Footlambert

Footlambert is a measure of **luminance (photometric brightness)**. It measures the amount of light emitted or reflected from a certain area of a surface. A surface emitting 1 lumen per square foot of surface has a luminance of 1 footlambert.

ILLUMINATION REQUIREMENTS

Adequate lighting is determined by both the quantity and the quality of the light. Quantity is the amount of illumination that produces the luminance of the task and surrounding area. Quality in lighting pertains to the distribution of luminances in a visual environment and is used in a positive sense to imply that all lights contribute favorably to comfort, safety, and aesthetics as well as ease of seeing.

1. Quantity of Illumination

The Illuminating Engineering Society has prepared standards of practice for application to schools. Illumination levels recommended by the federal Department of Energy are given in Table 6.

Table 6. Recommended Illumination Levels/Department of Energy

Task or Area	Footcandle Levels
Hallways or corridors	10 ± 5
Work and circulation areas surrounding work stations	30 ± 5
Normal classroom work, such as reading and writing (on task only), store shelves, and general display area	50 ± 10
Prolonged classroom work which is somewhat difficult visually (on task only)	75 ± 15
Prolonged classroom work which is visually difficult and critical in nature (on task only) (Figure 8)	100 ± 20

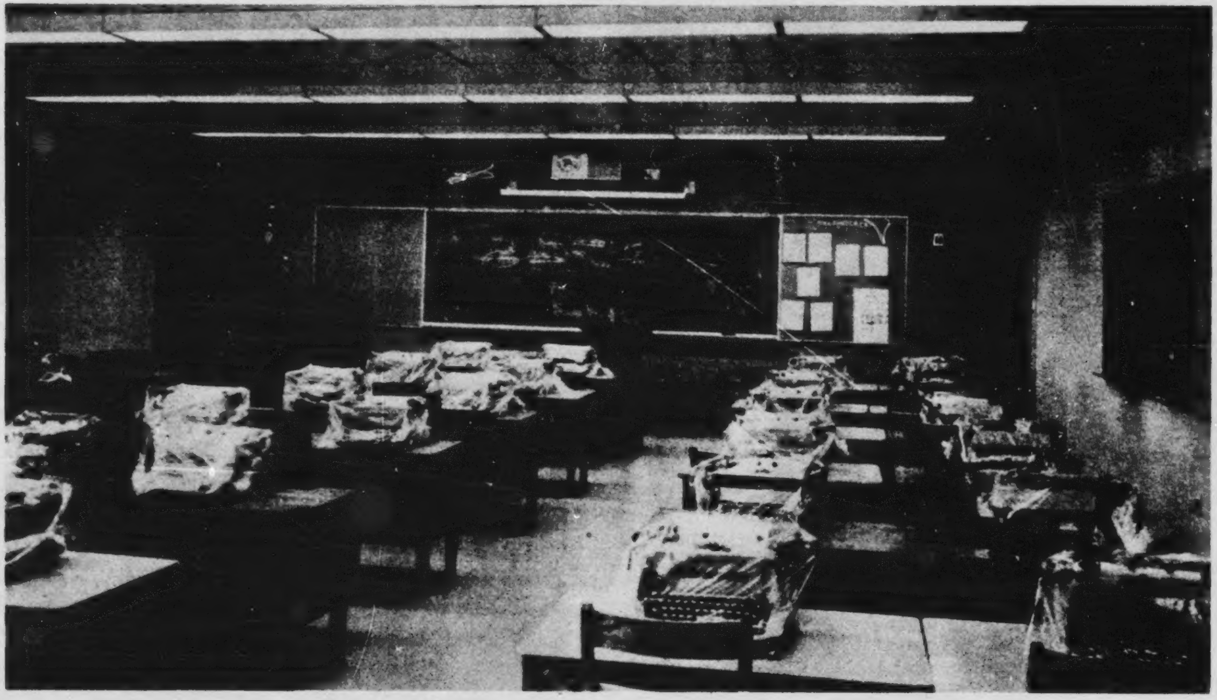
2. Quality of Illumination

Glare: A major detriment to proper lighting is the adverse quality factor known as glare, or large luminance difference. Glare may be defined as high luminance causing fatigue, discomfort, or even interference with a seeing task. It has several classifications, the first being direct glare due to bright sources of light in the field of vision. An unwelcome condition may be caused by small areas of high luminance amid larger areas of lower luminance. Reflected glare is the reflection of light from bright surfaces such as desk tops, walls, ceilings, floors, or windows.

It has been found that the adverse effects of glare are cumulative, meaning that for a short time it may not be annoying but as the subject sits in an area of glare he becomes progressively more fatigued. There are two degrees of glare — discomfort glare and disability glare. Discomfort glare produces discomfort, eyestrain, headaches, and fatigue but does not necessarily interfere with visual performance or visibility. Disability glare does not cause pain, but reduces the visibility of objects to be seen.

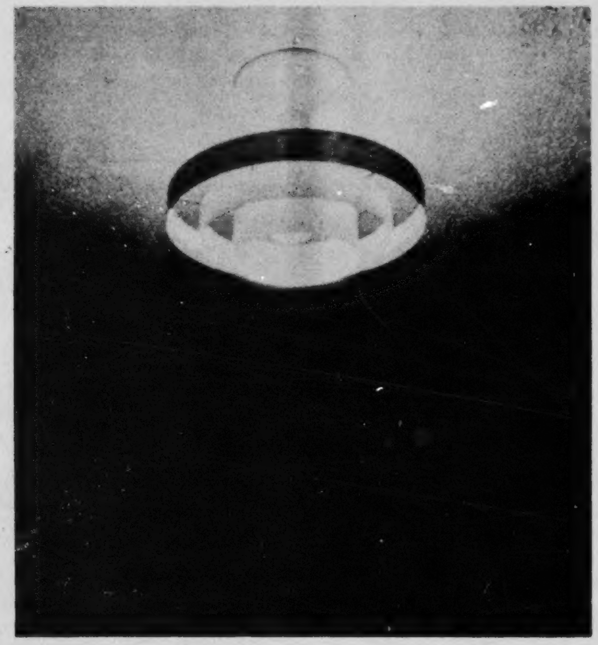
A basic rule for avoiding glare and also areas of shadow in a lighted room is that the lighting should be diffuse, i.e., it should come from many directions. A single spot source causes both glare and shadows. It should be remembered, however, that special seeing tasks such as needed in a

Figure 8. Fine Detail Work Rooms



shop or at a drafting board may require an individual directional source of light at the point where the work is performed. The effects of glare can also be avoided or minimized by mounting luminaries as far above or away from normal lines of sight as possible, and by limiting their luminance and quantity of light emitted toward the eyes. In general, this can be done by shielding luminaries to at least 25 degrees down from the horizontal and preferably down to 45 degrees. In other words, the luminance of bare lamps preferably should not be seen when looking in the range from straight ahead to 45 degrees above the horizontal (Figure 9.)

Figure 9. Incandescent Luminaire Shielded to Avoid Glare



Luminance distribution: The eyes function more effectively when the luminances within the visual environment are not too different from that of the seeing task. While performing a task the eyes become adapted to the luminance of the task. If, however, the eyes shift to view a higher or lower luminance and then back to the task, visibility of the seeing task will be reduced until the eyes readapt to the task luminance. To reduce this effect, maximum **luminance ratios** are recommended as shown in Table 7. The luminance ratio is defined as the ratio between the luminance of the seeing task and that of the visual surroundings.

Table 7. Maximum Luminance Ratios for School Lighting

Area	Brightness Ratio
Tasks to immediate surroundings	3:1
Minimum for chalkboard to surroundings	1:3
Tasks to surroundings more remote	10:1
Tasks to large remote bright areas	1:10
Luminaries or windows to surroundings	20:1
Anywhere within normal field of view	40:1

As an aid in achieving the above luminance ratios, the **reflectance** of room surfaces such as ceilings, walls, and floors are important. The reflectance is a measure of how much light is reflected from a surface and is expressed as the percentage of incident light that is reflected by the surface. Recommended classroom reflectance values are shown in Table 8.

Table 8. Recommended Classroom Reflectance Values

Surface	Reflectance (percent)
Ceiling	80 to 85
Window wall	75 to 80
Wall	50 to 70
Tackboards	50 to 60
Desk and table tops	35 to 50
Floors	15 to 30
Chalkboards	15 to 20

Room color greatly influences the effectiveness of a lighting system. Color and texture determine reflectance. For ceilings, a reflectance of 80 to 85 percent may be achieved by use of white or off-white finish. Ceiling color should extend 18 to 20 inches down the walls unless the ceiling is extremely low. Average wall reflectance should be 50 to 70 percent, obtainable by light pastel colors. It is important to give the window wall a little higher reflectance (as high as 75-80 percent around the windows) than other walls as daylight enters here and there are contrasts with the windows of high luminance. For floors, reflectance factors are 15 to 30 percent. Light colored linoleum and vinyl tile help produce a desirable effect and are also easier to clean than dark tiles. Desks and tables should be light colored or finished with a natural nonglare material.

3. Computing Required Illumination

It is not difficult to compute illumination levels which may be expected from a selected light arrangement. A simple method for making such computations is known as the lumen method. First, the type of system is chosen, based upon the manufacturer's description, personal taste, and other factors. Next, a symmetrical lay-out of the luminary selected is made. Maximum spacing is usually fixed by the choice of luminary and the ceiling height of the room. Also, as shown in many lighting catalogues, a table of factors for lighting fixtures is available showing the ratio of light from the source to the light reaching the working plane. These factors are known as **coefficients of utilization.** The required light value should be selected from a table of recommended light levels. The illumination which will be provided by a selected luminary is given by the following formula:

$$\text{Illumination (footcandles)} = \frac{\text{total lamp lumens} \times \text{coef. of utilization} \times \text{maintenance factor}}{\text{Area in square feet}}$$

The maintenance factor accounts for the decrease in illumination following installation of a system. This decrease in light output depends upon the choice of lamp, its age, the dirt which collects on the luminary, and the dirt which collects on ceilings, walls, etc. The normal range for the maintenance or use factor is between 0.4 and 0.8. It is lower for dirtier areas where fixtures may be rarely cleaned, for indirect lighting fixtures, and for fixtures with high internal reflection.

LIGHT SOURCES

Daylight and electric light are the two main sources of light. The use of daylight should be encouraged because of the saving in energy and also to obtain benefit of its wide spectrum. The design of new buildings should permit the best possible use of natural lighting conditions. The recommended window-glass area of a classroom is usually 15 to 20 percent of the floor area. In the Northern Hemisphere, school buildings should generally be oriented so that northern window exposures are obtained.

Because adequate daylight is not always available, some means for artificial lighting should be installed in every classroom. It is important that areas of sharp shadow change be avoided in placing light sources and that uniform levels of illumination be achieved. Where light sources are placed too far apart, a person working midway between them will be in an area of insufficient illumination. Installation of an additional light fixture eliminates this difficulty.

Types of artificial light which may be utilized in school buildings are incandescent and fluorescent. Fluorescent light, in general, is more economical since a minimum of energy is wasted as heat and most of the electric energy supplied to the lighting fixture is utilized as light. Although the initial cost of installation may be higher than for incandescent fixtures, operation and electrical costs are often lower.

When artificial lighting is used, the type of luminaries chosen should be based on the quantity and quality requirements of the space. A luminaire is a complete lighting device consisting of one or more lamps together with parts to distribute the light, to position and protect the lamps, and to connect the lamps to the power supply. Artificial lighting systems are classified into five types according to their light distribution. These are shown in Table 9.

Table 9. Classification of Artificial Lighting Arrangement

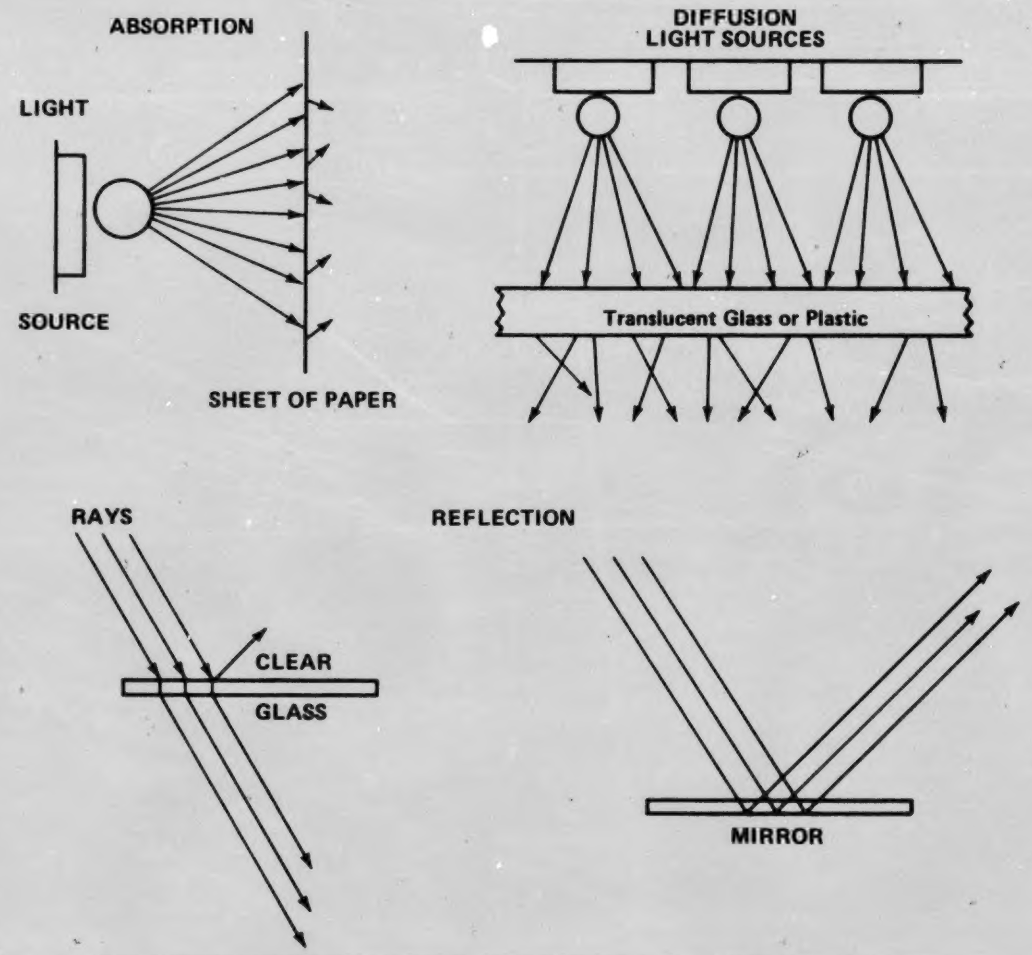
Type of System	Percent of Light Directed Upward	Percent of Light Directed Downward
Indirect	90-100	10-0
Semi-indirect	60- 90	40-10
General diffuse	40- 60	60-40
Semi-direct	10- 40	90-60
Direct	0- 10	100-90

In achieving these distributions, three basic principles are employed. These are absorption, diffusion, and reflection (Figure 10). Absorption may be illustrated by placing a light source behind a piece of brown paper. A dull glow on the side of the paper away from the light source indicates that a little of the light has passed through, but most of it is absorbed by the material of the paper. Objects behind the paper are not seen. The principle of diffusion is illustrated by a piece of translucent glass. This allows much light to pass through, but objects on the other side cannot be recognized clearly. When light strikes a surface, a part of this light is thrown back into the original medium, this is called reflection. If the surface is smooth, reflection is regular, otherwise it is diffuse. A transparent piece of glass reflects very little, while a mirror reflects almost 100 percent.

Although the indirect types in Table 9 are less efficient, they produce more comfortable lighting than the more efficient direct types. Because direct types may produce disturbing shadows and glare, they should be confined to storage areas or spot applications.

The general diffuse lighting is also known as "direct-indirect" lighting. For diffuse light distribution, the indirect installation is effective because ceiling or wall surfaces act as the light source. Shadows are minimized and glare is controlled. Where such an installation is provided, ceilings should be of a light color, white, or near white. Ceilings should also have a flat finish to control direct reflections or image reflections

Figure 10. Principles of Light Control



of the lamp. In general, diffuse lighting is more even because more light is absorbed by the room surfaces before it reaches the working place.

LIGHTING SURVEY

A lighting survey can be as simple or as comprehensive as described, but in any case three essential quantities are determined: illumination (footcandles), luminance (footlamberts), and reflectance (percent). Many types of light-measuring instruments are available, but the most commonly used is a light meter. It operates by means of a photoelectric cell, which causes a small electric current when struck by direct or indirect light. The current is connected to a micro-ammeter for direct reading of illumination in foot candles. A pocket-size light meter is shown in Figure 11.

Figure 11. Light Meter

FOOTCANDLES

One of the sources of error in an inexpensive light meter is that it does not respond to colored light as does the human eye, and it is most sensitive to light reaching the plane of the photoelectric cell from a perpendicular direction. To account for the response of the eye to light and to compensate for light reflected from the light-detecting cell surface, a light meter should be "color corrected" and "cosine corrected."

Ordinary light meters may be used to approximately determine luminance. For reflecting surfaces, the cover plate should be held directly against the surface, then slowly drawn back a few inches. Luminance in footlamberts is the reading in foot candles.

To estimate the reflectance of a surface, the illumination and luminance are first determined. The ratio of luminance in footlamberts and the illumination in foot candles is the reflectance.

COST OF LIGHTING

The following factors should be included in estimates of lighting costs:

(1) Initial cost of the fixtures and installation.
(2) Cost of power consumed.
(3) Maintenance cost for cleaning and relamping.

Relamping may prove to be a considerable factor in the cost of the system. The lumen of a light source diminishes with use, and it is usually more economical to replace lamps before they burn out. Individual replacement of lamps is called "spot replacement," and mass replacement of lamps is called "group relamping." Lamp manufacturers have brochures describing group relamping schedules. Normally, the saving in labor cost by group relamping should compensate for the value of the depreciated lamps that are thrown away before they burn out.

Three simple rules should be observed to get the most out of the lighting installation:

(1) Maintain wall and ceiling surfaces in a clean, freshly painted condition.
(2) Have a regular checkup schedule for replacing burned out lamps.
(3) Clean fixtures at least once a month, depending upon atmospheric conditions.

The use of efficient lighting techniques is vital to energy conservation. An energy conservationist or qualified engineer should be consulted to determine how to efficiently provide adequate illumination to conserve energy and reduce costs. Chapter 10, "Thermal Environment," and Appendix B also address energy conservation.

Chapter 10
THERMAL ENVIRONMENT

PUBLIC HEALTH RATIONALE

Proper temperature, humidity, and ventilation contribute to a healthful and comfortable environment.

GENERAL

The concept of the thermal environment embraces the functions of air heating, cooling, humidity control, and air distribution. Distribution in turn implies the delivery of fresh air and the removal of used air. These functions in a school environment are important in achieving student and staff comfort, efficiency, and health. An air conditoning system that is properly designed, controlled, and operated can produce conditions that impede the spread of respiratory infections.

The human body is capable of adjusting to extremes of heat and cold, as well as humidity. Five basic changes can occur in the air of an unventilated, occupied room:

(1) Body heat raises the temperature.
(2) The breath and perspiration of occupants raise humidity.
(3) Partially oxidized organic matter is released into the air in small amounts by occupants.
(4) The oxygen content is reduced.
(5) The carbon dioxide content is increased.

As these conditions progress, the air of an occupied space becomes increasingly unsatisfactory for human comfort and occupancy. It is the function of air conditioning to maintain the proper limits of temperature and humidity.

CLASSROOM TEMPERATURE LEVELS

The problem of defining ideal thermal conditions is complicated by factors such as metabolic heat of the individual, artificial lighting, solar radiation, heat loss or gain through the walls, infiltration of outside air, odors, and air motion. Nevertheless, recommendations for comfortable conditions are found in numerous texts and publications by groups such as the American Society of Heating, Refrigerating, and Air Conditioning Engineering (ASHRAE). Temperature requirements for various types of classrooms cover a rather narrow range of dry-bulb temperature. A range of 68°F to 74°F during winter months and a range of 74°F to 79°F during summer months are considered satisfactory. However, during a severe winter energy crisis these recommendations may need to be reduced to 65°F, temporarily. Study has shown that children are generally more comfortable if temperatures are somewhat cooler than those considered ideal by adults. When students in the classroom are moderately active, the lower limit mentioned above is desirable; when they are less active, the higher limit may be more comfortable. A temperature of 65°F or slightly lower is recommended in gymnasiums, except for higher temperatures in locker and shower rooms (75°F-80°F) and pool areas (83°F). It is important that the temperature be measured at the level of the students seated and not at "eye level" of the standing unit.

VENTILATION

Ventilation is the process of supplying air to and removing air from a space. It is one of the most important techniques to maintain the quality of air in the school environment. It may be accomplished by natural or by mechanical means. Fresh outdoor air is introduced into the air system of a school building to provide a basic minimum quantity of air necessary for healthful respiration by the occupants. Generally the minimum quantities of air needed for breathing come in through crevices in the building, through leaks around windows and doors, and through the process of opening and closing doors and windows. Individuals sharing responsibility for design, funding, and construction of school facilities often disagree about the specifications for minimum ventilation rates. The amount of ventilation required for oxygen replacement and carbon dioxide removal is at least 1 to 2 cubic feet per minute (cfm) per person; however, unless greater amounts of clean air are provided, odor buildup would be excessive at these rates, as would increases of air temperature and humidity in the non-heating seasons. Therefore, a minimum clean replacement of 10 cfm per person in the classroom is generally recommended. However, with a central air distribution system it is not necessary to use 10 cfm per person of outside air for the building as a whole, provided equipment for odor removal is utilized. This equipment should use recirculated air for the most part, and only 3 to 4 cfm per person of outdoor air.

It is important that air delivered to a classroom be distributed in a manner such that drafts are minimized or eliminated. Air velocity in the occupied zone should be no higher than 25 feet per minute (fpm). In warm weather, ventilation air velocity should be raised to 100 fpm or more, unless air cooling is provided. In that case, the 25 fpm limit should be adhered to in order to avoid chilling drafts on some of the occupants.

HUMIDIFICATION AND DEHUMIDIFICATION

The control of humidity at times requires humidification (adding moisture to the air) and at other times dehumidification (removing moisture from the air). The consequent drying out of the nasal mucous membranes may increase the susceptibility of students to respiratory infection. Humidification of the air under these conditions is desirable to a level of 30% relative humidity, although actual limits may be imposed by the formation of ice on the windows during the winter months. Some degree of dehumidification is inherent when any air cooling system is used. However, the removal of latent heat (the condensation of moisture in the air) is more expensive to accomplish than is the removal of sensible heat. Therefore, most air cooling equipment is designed to remove as much sensible heat as possible.

TYPES OF HEATING

1. Central forced air system

This is generally a large system to serve several spaces or a substantial portion of a school. In their simplest form, the central fan and coil deliver treated air to a number of spaces. The temperature of the air is necessarily the same going to each space. Although some control may be obtained by varying the volume of air to each room, temperature control generally is not good, and the system cannot be made to cool one space and heat another simultaneously. The same ducts and fan can be used for cooling as well as for heating if each has a capacity of 25 percent greater than that required for heating alone.

The central forced air system is more efficient because a larger and more efficient cooling unit is used. Also, the cooling capacity does not have to be as large as the sum of equivalent smaller units. This is true because peak loads will not occur simultaneously in many spaces; yet, with individual equipment, each piece would require a rating equal to the peak load in the space which it would serve.

A system for heating with a heat pump can be considered in conjunction with a central cooling unit. The heat pump collects heat and transfers it from one place to another. In winter it takes heat from the outside air and transfers it into the building; in summer it takes heat from inside the building and transfers it outdoors.

2. Individual unit system

This is a system in which air is tempered in the immediate vicinity of the area to be heated. Each unit is located beneath the windows of the room and acts as the escape point for heat produced by steam, hot water, or electricity. Such a system can also be adapted for cooling by using direct expansion units and circulating chilled water through the pipes. Direct expansion coil units are somewhat noisier than chilled water units because a motor and compressor are used.

3. Panel and radiant heating systems

These systems are advantageous for certain purposes in the overall heating system of a school. Both methods are based on the transfer of heat by radiation rather than by heated air, as in the previously discussed systems. In panel heating, large surface areas are heated to temperatures of 80°F to 140°F by warm water piping, warm air ducts, or electrical elements embedded in the walls, floors, or ceilings. The heating of slab-on-grade floors in this way is desirable for primary classrooms where children spend much time on the floor. However, the exclusive use of warm panels as a heating means is generally more expensive than other heating systems, and not suitable for extreme climate or rapidly changing loads. In buildings heated by electricity, radiant-type heating is supplied from a ceiling cable buried in the plaster, or from electric elements behind glass or metal panels on walls or baseboards. Hot water piped through radiators, flooring, or baseboards also provides heat by radiation.

TEMPERATURE CONTROLS

Two common types of controls are those controlling the flow of air volume and those controlling temperature in various rooms. The exhaust inlets of air ducts are often equipped with louvers to regulate the flow of air into a room. With respect to the distribution of heating and cooling media, thermostats to control temperature are ordinarily placed in each room or zone (group of rooms) in the school. The function of the thermostat is to measure the temperature in the control space and to send a signal to an appropriate control element. Care should be taken to place thermostats in locations free from unusual sources of heat and coolness, and to prevent students from promiscuously adjusting the thermostat. For larger systems and nighttime operation, a central thermostat should be installed which will control the over-all temperature of the building at a lower level than that which is required during class hours. Installation of a dual or "day and night" system is not complicated and pays dividends in fuel savings.

ENERGY SOURCES

There are three common fuels: oil, gas, and coal. While a number of schools still use coal burning boilers, fuel usage has shifted almost completely to oil and natural gas. Within the past several years, a significant number of new schools have been designed with "all electric" energy systems. However, electric heat is less efficient than oil or gas heat. The use of solar energy also becomes a distinct possibility. A number of schools have been equipped by the Department of Energy with experimental solar heating and cooling systems.

The exact type of fuel to be chosen should be based on the economics of the situation as well as the availability of the fuel. Oil has the advantage of the lowest unit energy cost besides coal. Generally, maintenance of oil handling and burning equipment is more costly than for other fuels. The price of oil fluctuates more than that of any other fuel, and the trend is toward higher prices. Natural gas is generally considered to be cleaner than oil and coal. It burns more completely, leaves no ash or residue, and does not deposit as much carbon on furnace surfaces. However, in recent years, gas supplies have not been reliable in all areas of the country during winter months.

COLOR AND ITS THERMAL RELATIONSHIPS

Color plays a definite but little defined part in establishing the comfortable thermal environment which will aid the student's receptivity to learning. There is a psychological reaction to color which has an indirect effect on thermal recognition and a directly related effect on the pupil's general disposition and enjoyment of going to school.

Color guides could be established that facilitate decision making with regard to determining the dominant hue, color value (tone), chroma (purity of color), and contrast. The value will depend on how much light is intended to be reflected from the room surfaces (see Chapter 9). Selection of color in terms of temperature will depend on the orientation of the room (North or South mainly), the nature of the immediate environment, size of room, duration of use, appropriate temperature, methods of lighting, and noise level.

In schools with windows, rooms having North exposure appear more agreeable if decorated with "warm" colors; rooms with windows on the sunny side seem more comfortable if "cool" colors are applied. Although we do not know the exact relationship between color and emotions, there seems to be a clear indication that different colors cause a variety of psychological changes in people. Red, yellow, orange, and violet are colors often associated with warmth, excitement, and stimulation, while blue, green, and grey colors are associated with coolness and restfulness. The harmonious color relationships established will play a major part in establishing "the atmosphere" of the school.

In schools, even those without windows, the functional purpose of colors should be considered in conjunction with educational and architectural planning, as well as the mechanical design and illumination to improve efficiency and well-being (as in industry) while reducing body fatigue. This brings color very much into the field of direct thermal considerations for the different spaces in schools.

MEASUREMENTS

As in the case of acoustics and lighting, design and installation of air conditioning systems require the services of persons skilled in such work. However, the school principal, science teacher, or custodian should be able to readily determine heating and ventilating conditions. The instruments required are not complex and consist of the following:

- A psychrometer – mechanically or hand-operated device for determining humidity.
- A dry-bulb thermometer.
- An anemometer or air velocity-indicating device.

Psychrometers are available in three types: (1) A so-called sling model which consists of a dry-bulb thermometer and a wet-bulb thermometer mounted on a stick which the user whirls around rapidly; (2) dry-bulb and wet-bulb thermometers attached to a small stand with a motor-driven fan; and (3) a simple holder of a dry-bulb and a wet-bulb thermometer with a reservoir for keeping wet a cloth sock on the sensing element of the wet-bulb thermometer. The sling model is shown in Figure 12. By the use of these devices and by referring to a table of differences between wet-bulb and dry-bulb temperatures as in Table 10 or by referring to

Figure 12. Sling Psychrometer

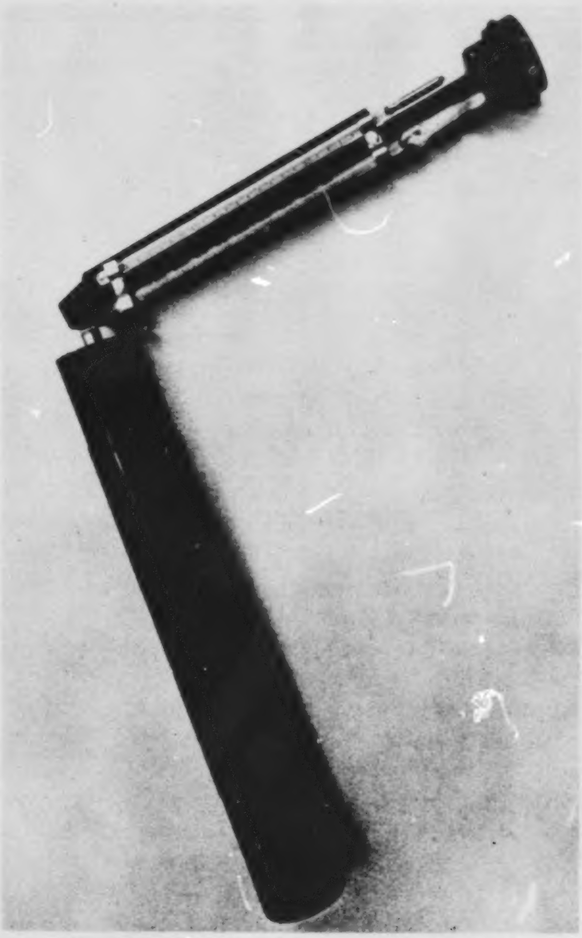


Table 10. Relative Humidity Values Based on Dry-Bulb Temperature and Difference Between Dry-Bulb and Wet-Bulb Temperatures*

Dry Bulb Temperature °F	DIFFERENCE BETWEEN DRY BULB AND WET BULB TEMPERATURE °F AT 15 FT./SEC. MINIMUM AIR VELOCITY OVER WET BULB																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
43	92	85	77	70	63	55	48	42	35	28	21	14	8	1							
44	93	85	78	71	63	56	49	43	36	30	23	16	10	4							
45	93	86	78	71	64	57	51	44	38	31	25	18	12	6							
46	93	86	79	72	65	58	52	45	39	32	26	20	14	8	2						
47	93	86	79	72	66	59	53	46	40	34	28	22	16	10	5						
48	93	86	79	73	66	60	54	47	41	35	29	23	18	12	7	1					
49	93	86	80	73	67	61	54	48	42	36	31	25	19	14	9	3					
50	93	87	80	74	67	61	55	49	43	38	32	27	21	16	10	5	0				
51	94	87	81	75	68	62	56	50	45	39	34	28	23	17	12	7	2				
52	94	87	81	75	69	63	57	51	46	40	35	29	24	19	14	9	4				
53	94	87	81	75	69	63	58	52	47	41	36	31	26	20	16	10	6	1			
54	94	88	82	76	70	64	59	53	48	42	37	32	27	22	17	12	8	3			
55	94	88	82	76	70	65	59	54	49	43	38	33	28	23	19	14	9	5	0		
56	94	88	82	76	71	65	60	55	50	44	39	34	30	25	20	16	11	7	2		
57	94	88	82	77	71	66	61	55	50	45	40	35	31	26	22	17	13	8	4		
58	94	88	83	77	72	66	61	56	51	46	41	37	32	27	23	18	14	10	6	1	
59	94	89	83	78	72	67	62	57	52	47	42	38	33	29	24	20	16	11	7	3	
60	94	89	83	78	73	68	63	58	53	48	43	39	34	30	26	21	17	13	9	5	1
61	94	89	84	78	73	68	63	58	54	49	44	40	35	31	27	22	18	14	10	7	3
62	94	89	84	79	74	69	64	59	54	50	45	41	36	32	28	24	20	16	12	8	4
63	95	89	84	79	74	69	64	60	55	50	46	42	37	33	29	25	21	17	13	10	6
64	95	90	84	79	74	70	65	60	56	51	47	43	38	34	30	26	22	18	15	11	7
65	95	90	85	80	75	70	66	61	56	52	48	44	39	35	31	27	24	20	16	12	9
66	95	90	85	80	75	71	66	61	57	53	48	44	40	36	32	29	25	21	17	14	10
67	95	90	85	80	75	71	66	62	58	53	49	45	41	37	33	30	26	22	19	15	12
68	95	90	85	80	76	71	67	62	58	54	50	46	42	38	34	31	27	23	20	16	13
69	95	90	85	81	76	72	67	63	59	55	51	47	43	39	35	32	28	24	21	18	14
70	95	90	86	81	77	72	68	64	59	55	51	48	44	40	36	33	29	25	22	19	15
71	95	90	86	81	77	72	68	64	60	56	52	48	45	41	37	33	30	27	23	20	17
72	95	91	86	82	77	73	69	65	61	57	53	50	45	42	38	34	31	28	24	21	18
73	95	91	86	82	78	73	69	65	61	57	53	50	46	42	39	35	32	29	25	22	19
74	95	91	86	82	78	74	69	65	61	58	54	50	47	43	39	36	33	29	26	23	20
75	96	91	86	82	78	74	70	66	62	58	54	51	47	44	40	37	34	30	27	24	21
76	96	91	87	82	78	74	70	66	62	59	55	51	48	44	41	38	34	31	28	25	22
77	96	91	87	83	79	74	71	67	63	59	56	52	48	45	42	39	35	32	29	26	23
78	96	91	87	83	79	75	71	67	63	60	56	53	49	46	43	39	36	33	30	27	24
79	96	91	87	83	79	75	71	68	64	60	57	53	50	46	43	40	37	34	31	28	25
80	96	91	87	83	79	75	72	68	64	61	57	54	50	47	44	41	38	35	32	29	26
82	96	92	88	84	80	76	72	69	65	61	58	55	51	48	45	42	39	36	33	30	28
84	96	92	88	84	80	76	73	69	66	62	59	56	52	49	46	43	40	37	35	32	29
86	96	92	88	84	81	77	73	70	66	63	60	57	53	50	47	44	42	39	36	33	31
88	96	92	88	85	81	77	74	70	67	64	61	57	54	51	48	46	43	40	37	35	32
90	96	92	89	85	81	78	74	71	68	65	61	58	55	52	49	47	44	41	39	36	34

*Adopted from Technical & Engineering Data Section, Air Conditioning, Ventilation, Refrigeration, *Engineers Product File – 1960.*

a psychrometric chart (Figure 13), the amount of relative humidity may be determined.

The second piece of equipment is the dry-bulb temperature thermometer, which can be obtained in various models, including some which can be carried in protective steel cases.

The third instrument is the anemometer. Two basic models of this instrument are available, one of which depends on a rotating shaft with attached blades which pick up the air motion and transmit it by mechanical means to a dial reading in feet per minute of air velocity (Figure 14). The second device operates on an electric principle, is self-contained in a small kit, and is battery operated. It depends upon the effect of air passing over a small heated element. This instrument also has a direct reading dial showing air velocity in feet per minute; it is also

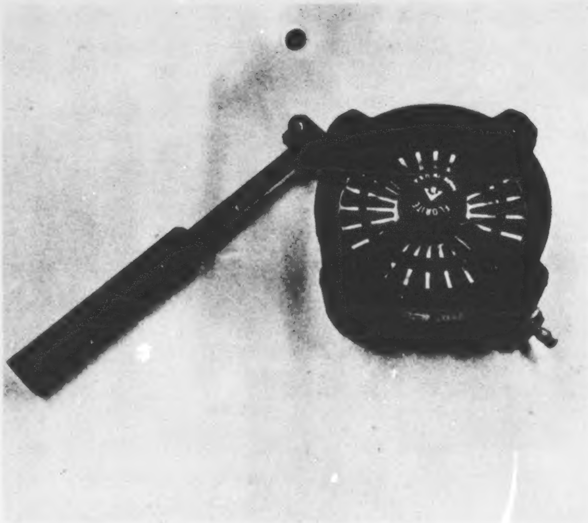


Figure 14. Anemometer

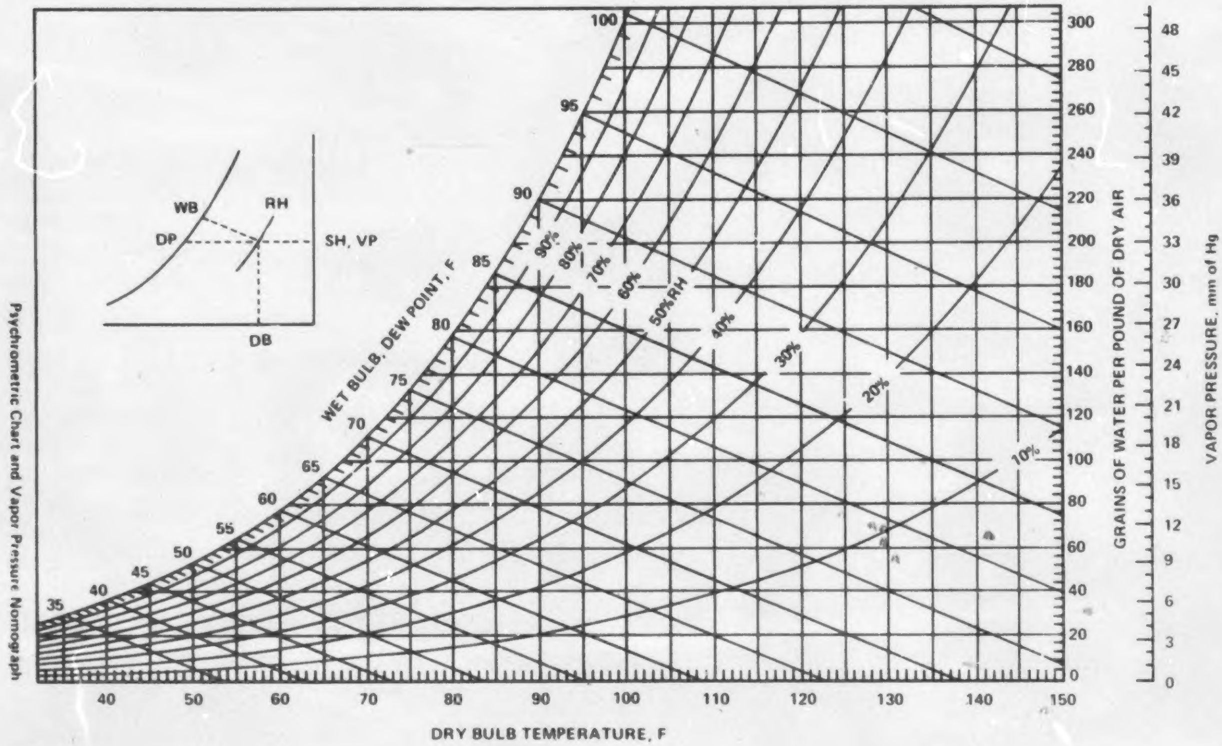


Figure 13. Psychrometric Chart and Vapor Pressure Nomograph

useful in rapidly determining room air temperature. This instrument can be used to find draft channels and to check air velocities at duct outlets.

ENERGY CONSERVATION

On April 20, 1977, President Carter presented to Congress his plan for managing America's energy future, formally initiating a national crusade that will stretch into the next decade. One major strategy of his plan involved the conversion of industry and utilities using oil and natural gas to coal and other more abundant fuels, reducing imports, and making natural gas more widely available for household use. School administrators and planners should be aware of current energy needs and participate when and where appropriate to conserve energy and utility costs.

Many educational institutions have reported substantial cost savings and reductions of energy on campus as a result of vigorous self-initiated energy management programs. These energy savings are documented in a two-volume publication, *Energy Conservation on Campus,* issued by the Department of Energy. Copies are available for a nominal charge from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402.

The Department of Energy has available for purchase or loan a variety of audiovisual programs regarding energy facts, conservation, and available sources of energy. The free-loan programs are available from: Modern Talking Picture Service, 2323 New Hyde Park Road, New York 11040. Audiovisuals may be purchased from: National Audiovisual Center, General Services Administration, Order Section, Washington, D.C. 20409.

Chapter 11
ACOUSTICS

PUBLIC HEALTH RATIONALE

Excessive sound levels have a variety of effects on people. An important physiological effect is permanent hearing impairment. In educational facilities, the main effects are interference with communication and disturbance and annoyance due to noise (unwanted sound). It has been shown that noise has a serious effect on student attention and concentration, causing students to make more mistakes and work less efficiently.

THE NATURE OF SOUND AND ITS MEASUREMENT

In air, sound is usually described in terms of oscillation in pressure above and below the ambient atmospheric pressure (sound pressure). The rate of pressure oscillation is the frequency which is measured as cycles per second (cps) or hertz (hz). A young person with normal hearing will be able to perceive sounds of frequencies between approximately 16 and 20,000 hz at moderate sound pressure. The sound pressures between the threshold of hearing, for normal young people about 0.00002 Newtons/square meter (N/m^2), and the threshold of discomfort, about 20 N/m^2, covers a range of 1 to 1,000,000. This range cannot be scaled linearly because such a scale would be too long to be practical. A simple mathematical scale suited to this range of numbers is one based on the logarithm of the relative sound pressures. The range from 1 to 1,000,000 would be compressed to a scale running from 0 to 6. By definition, the decibel (dB) represents such a scale which is a dimensionless unit related to the logarithm of the ratio of a measured quantity to a reference quantity. The reference quantity is usually designated as 0.00002 N/m^2 in measuring sound pressure levels.

The decibel scale is extremely useful; however, the mathematical operations differ from those to which we are accustomed through normal use of linear scales. For example, the total sound pressure level resulting from two identical sound sources would not be the sum of the two sound pressure levels in dB, but rather would be 3 dB higher than the level produced by either source alone. For addition of sound pressure levels of two separate random noise sources use Table 11. The numerical difference between the levels L_1 and L_2 is used in Table 11 to find the value L_3. L_3 is then added to the larger of L_1 or L_2 to obtain the result of $L_1 + L_2$.

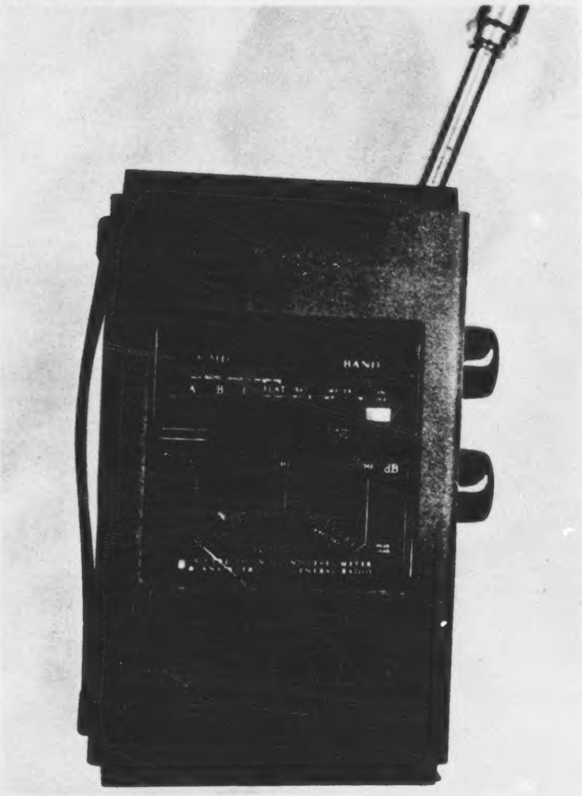
Table 11. Table for Combining Decibel Levels of Noises

Differences Between Decibel Levels (L_1 - L_2)	Number of Decibels to be Added to Higher Level (L_3)
0	3
1	2.6
2	2.1
3	1.8
4	1.5
5	1.2
6	1.0
7	0.8
8	0.6
10	0.4
12	0.3
14	0.2
16	0.1

In addition to responding to the magnitude of sound pressure, the human ear is sensitive to the frequency of the sound. In order to approximate the ear's response characteristics, the **sound-level meter** contains weighting networks that give greater importance to sounds in certain frequency ranges. The apparent loudness we attribute to sound varies with the sound pressure and its spectral content (the frequencies of the components of the sound). This effect is taken into account through the use of the weighting networks. The A-weighting network is emerging as the measure most often utilized in objective and subjective studies of noise.

In addition to the sound-level meter, there are other more sophisticated instruments which would be used in a more detailed survey of the acoustical environment. One of these instruments is called an **octave-band analyzer**. It is used to determine how sound energy is distributed with frequency. The frequency range of each band is such that the upper cut-off frequency is twice the lower cut-off frequency (Figure 15).

Figure 15. Sound Level Meter and Octave-band Analyzer



SOURCES OF NOISE

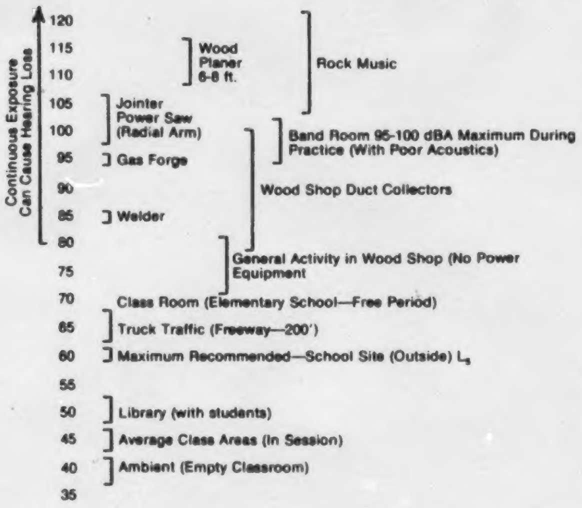
External sources of noise are heavily traveled streets, railroad yards and tracks, airports, factories, playgrounds, and low-flying planes. A reason for selecting a school site where the external noise level is not in excess of 70 decibels is that treatment of walls and windows to achieve reductions of more than 30 to 35 decibels is difficult and costly.

Internal noise sources are building machinery, air-conditioning equipment including air-conditioning air outlets, students walking in classrooms and corridors, and students playing in gymnasiums or using swimming pools and elevators. To control these sources of noise, the school building should be planned so that walls and ceilings are utilized to absorb as much sound as possible without deadening effects, and to insure that special areas such as auditoriums are acoustically as well as structurally designed. It is important that shops, gymnasiums, auditoriums, and band and choral practice rooms be located as far as possible from other teaching areas.

NOISE LEVELS IN A SCHOOL

Typical noise levels in a school originating from both internal and external sources are given in Table 12. It is shown that continuous exposure to noise above 80 dBA can cause hearing loss (the American Conference of Governmental Industrial Hygienists recommended an upper limit of 85 dBA for 8 hours exposure).

Table 12. Typical Noise Levels in a School*



*"School Noise and Its Control," *Journal of Environmental Health,* Vol. 36, No. 5, 1974.

Ranges of indoor design goals for the ambient sound levels emitted from mechanical equipment are listed in Table 13. Use of the "Noise-Criteria (NC) curve" is a more precise method for establishing design goals for satisfactory background noise inside buildings. It is helpful in deciding where in the spectrum additional effort is required in noise reduction to make the noise acceptable. A set of these NC curves is shown in Figure 16 and design goals are also listed in Table 13. The background noise should not be above these levels at the various frequencies. In order to adequately mask distracting sound, the noise should not be substantially below these levels. To use these NC curves, the measured spectrum is plotted on the chart. Each band level is compared with these curves to find the one that penetrates to the highest NC level. The corresponding value on the NC curve is the NC rating of the noise.

Figure 16. Noise Criteria Curves

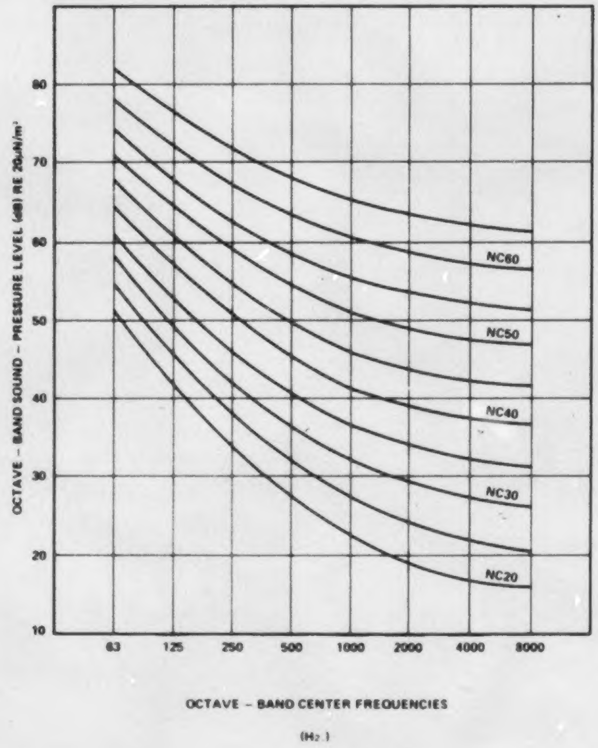


Table 13. Ranges of Indoor Design Goals for the Ambient Sound Levels Emitted from Mechanical Equipment*

Type of Area	Range of A Scale Sound Level dB	Range of NC Criteria Curve
Classrooms	35-45	30-40
Libraries	35-45	30-40
Laboratories	40-50	35-45
Recreation Halls	40-55	35-50
Corridors and Halls	40-55	35-50
Kitchens	40-55	40-50
Gymnasiums	40-50	35-45
Swimming Pools	45-60	40-50

*ASHRAE Guide, Chapter 35

ACOUSTIC PLANNING

1. General

Precision acoustic planning requires the services of acoustic consultants who should be retained either by school boards or the architect in charge of the school design project. The school authorities, however, can be aware of the general requirements for noise in the school building, and in the planning stage can require the levels which will be acceptable when the building is completed. Some general requirements for good acoustics are:

a. The reduction of transmitted sounds to levels which will not interfere with hearing.
b. Proper diffusion of sound and proper sound reinforcement.
c. Optimum reverberation time.

Reverberation is the persistence of sound in an enclosure after the source has stopped and is a result of reflections from the walls. Reverberation time is defined as the time required for sound in a room to decay to one-thousandth of the initial pressure. The optimum reverberation time varies with different types of facilities. The rapid succession of speech sounds, and the need to detect the separate sounds, causes a need for a relatively short reverberation time for voice communication. On the other hand, the choral concept requires the blending caused by the sustaining of sound. A longer reverberation time is therefore beneficial.

A number of vital points should be included in the planning process. The most important is that acoustical problems should be met at the earliest possible state of design and deferred to later levels only when it is certain that a satisfactory solution can be obtained. It is better to reject an undesirable site than to end up with a school plant which has acoustical problems that cannot be resolved.

A second and equally important point is that many of the acoustical requirements of a program should be developed early in the design process. There will, of course, always be a need for acoustical treatment of individual rooms; however, observation of existing buildings suggests that such "acoustical treatment" is too frequently used in an attempt to solve problems which could have been better solved earlier in the design phases.

A third point is the observation that several different categories of sound origins must be considered: off-site, on-site, within the building, and within rooms. Each category, of course, has approaches most suitable to it. For example, acoustical tile on the ceiling of a classroom cannot help significantly in controlling noise originating from an adjacent playground.

A fourth point is that both wanted sounds and unwanted noises are being considered, yet a treatment for one will affect the other. For instance, in an auditorium, the electronic magnification of a speaker's voice may also amplify the distortion reflected from a curved rear wall of the room.

Finally, there are a number of ways for the architect, in the planning process, to plan for wanted sound and unwanted noise. The acoustical requirements can be used as the basis for room shape or electronic aids can be incorporated to augment wanted sounds. Space relationship, distance, level change, and absorbent surface treatment materials can be used to reduce unwanted noise.

It should not be inferred from this brief outline of the architect's potential courses of action that the "add-on" solutions to acoustical design problems are always inferior. However, observation of existing buildings provides evidence that "add-on" solutions are often used when earlier design solutions would have been superior. To this extent, there is a need for a better coordination of acoustical determinants at each stage of the design process.

2. Acoustics and Site

At the time the school board purchases the site, consideration should be given to avoiding nearby noise producing elements — highways, railroads, industrial complexes, airport approaches, and the like. The Federal Highway Administration's recommended maximum allowable noise level near schools is 70 dBA exterior (L_{10} - 10% of the time). States such as Washington have set the limit to 60 dBA (L_5 - 5% of the time). Certainly this should also involve inspection of a master plan for the growth and development of the surrounding area as it might reveal projected roads, industrial complexes, airport developments, and other incompatible zoning which would render what initially may be a satisfactory site, an acoustically difficult site in the future.

The size of the tract chosen affects the acoustics of a school. If noise producing elements in the surrounding environment can be kept subsequently distant from the school by placing it on a large site, this should be considered. A wooded site, particularly one wooded at its perimeters, will help shield surrounding noise; terrain features, such as hills, rises, and man-made earthworks which raise topographical shields at the edge of the site, may also be considered.

Once a site has been selected and the planning process begun, further acoustical considerations should be raised:

a. The building complex can be positioned on the site so as to reduce the acoustical interference from surrounding elements, perhaps by situating part of the structure below grade or eliminating windows when possible.
b. Landscaping can be planned to reduce traffic noise and other disturbances.
c. Terrain features can be introduced to further reduce acoustical interference; earth taken in digging foundations can be used

to mold a hill or rise as a barrier to external noise.

d. Parking lots, entrance roads, and school bus loading zones can be planned to be as remote as possible from classrooms, libraries, and other "quiet areas."

e. Playgrounds and athletic fields can be located in remote areas of the site or positioned so that acoustical barriers in the form of landscape, solid walls, or other building elements separate them from academic spaces.

f. Outdoor sitting areas and circulation and "waiting areas" associated with auditoriums and cafeterias should be located so as not to interfere with the quiet areas of the school.

g. Finally, the School Board can work with local planning agencies in developing a master plan which will insure acoustically appropriate sites.

NOISE CONTROL

Noise must first be controlled at its source. Motors, pumps, and plumbing apparatus are notorious sources of noise. The most satisfactory solution is the introduction of flexible connections in the otherwise metallic systems. Noisy motors and pumps may also be quieted by preventive maintenance. Noise created by sanitary and storm drainage can be reduced by using sound-deadening material or resilient connections between piping and basic building structure.

Another principal source of noise in a school building is the ventilating or air-conditioning system fans, air ducts, and inlet and outlet grills. In new building design, air distribution and return ducts should not pass through several rooms, but should feed into a central duct over a corridor or similar area. Quiet grills, motors and fans can be installed. The streamlining of air transmission systems and the application of absorptive materials to the interior of the duct system will also aid in the reduction of noise. It is important to locate air handling machinery so that it will be as far as possible from occupied areas, and to use isolators to minimize transmission of vibration and noise into the building structure.

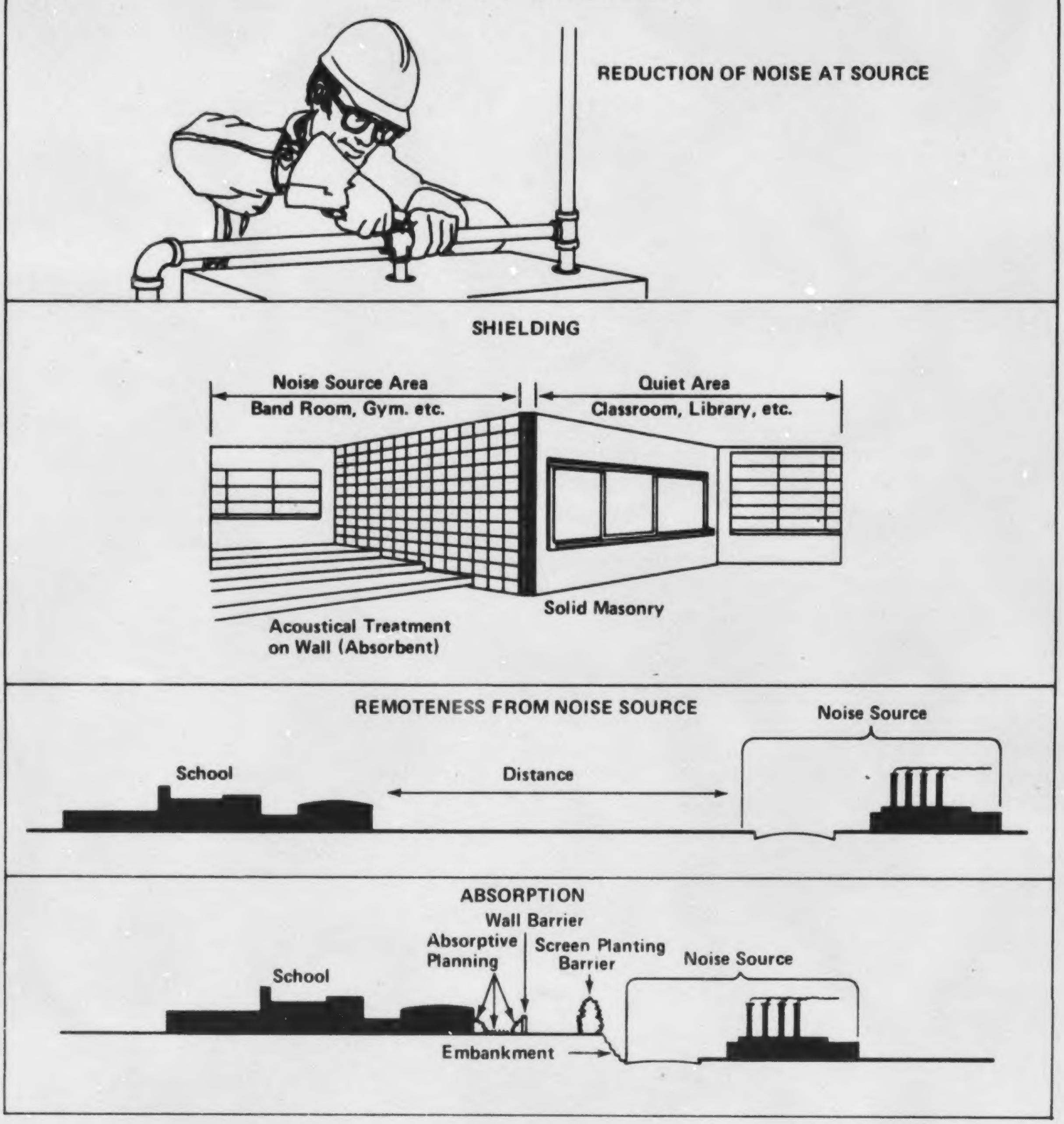
The second consideration is noise control shielding or interposing a noise-attenuating barrier between a noise source and the person affected. Sound is transmitted in two ways: (1) airborne transmission, in which air leaks through or around the partition, permitting sound to pass through, and (2) diaphragmatic transmission, in which the energy of sound waves causes the partition to vibrate, in turn activating air particles on the opposite surface. Control of noise transmission, therefore, involves (1) minimizing the occurrence of air leaks usually found at floor and ceiling joints and around openings and (2) incorporating materials with low sound transmission qualities.

In selecting construction materials, a common error is to suppose that a partition made up of a porous, sound-absorbing material will be an effective sound barrier. In fact, this may turn out to be a poor divider because it provides air paths through the porous materials. In addition to transmission through air passages, partitions formed of plywood, thin solid plaster, gypsum board, and other light weight construction can act as diaphragms and become serious offenders in transmitting sound from one space to the next. A heavy wall will tend to offer high resistance to vibration because of its inertia. A general rule of sound barrier construction is that the amount of noise reduced is directly proportional to the density of the material making up the sound barrier. In addition to using a sound barrier between rooms, the room arrangement should locate the speaker near the source of noise. It would be an advantage to have teachers "back-to-back" on the two sides of a dividing partition. In this way, one could avoid having students in the back of a room hear and be disturbed by a teacher conducting a class immediately on the other side of a relatively poor dividing partition.

The third consideration is that of separating the school buildings as far as possible from noise sources. A building removed a few hundred feet from a busy street will receive less traffic noise than one which directly faces a sidewalk adjacent to the street curb.

The fourth consideration in sound reduction is noise or sound absorption. Shrubs, trees, earthen embankments, and masonry walls that have been given special arrangement act as absorbers of sound, as do grass turf areas and dense vine growths. Care should be taken, however, to place plants in such a way that ventilation and natural light are not reduced. If the ground surrounding a school is generously provided with turf, vines, and other sound-absorbing media, reduction of noise may be as great as from 8 to 18 decibels (Figure 17).

Figure 17. Sound Problem Solutions


REDUCTION OF NOISE AT SOURCE
SHIELDING
Noise Source Area
Band Room, Gym. etc.
Quiet Area
Classroom, Library, etc.
Solid Masonry
Acoustical Treatment on Wall (Absorbent)
REMOTENESS FROM NOISE SOURCE
Noise Source
School
Distance
ABSORPTION
Wall Barrier
Absorptive Planning
Screen Planting Barrier
Noise Source
School
Embankment

Within the school building acoustic tile is widely used for sound absorption. Constructed of fibrous material, this tile may be obtained in either flat or perforated forms, which can be readily applied to wall and ceiling areas. Another method of creating a sound-absorbing surface is to give the plaster of walls and ceilings a rough finish. Special acoustic plaster can also be used. It should be mentioned that the average noise level can be reduced by increasing the absorption of a room, but the acoustical character of the room occasionally may be adversely affected.

SOUND SURVEY

Usually the science of acoustics is one which requires the services of an individual trained in this field. However, the school superintendent or individuals in the science department can do much to determine the general noise background and make comparisons between existing and desirable noise levels.

In a general sound survey, a sound-level meter is used. The operator reads directly in dB the sound level at the point where the measurement is being taken by selecting the proper scale and weighting network. Measurements should be taken at various locations within a room or an outdoor space so that a true picture of the overall condition is obtained. Contour maps of sound levels may be prepared, and will be found helpful in analyzing a noise problem. For more complex noise analysis, an octave-band analyzer may reveal that the sound is loudest in the low frequency range where shielding is difficult, or that the intensity is greatest in the high frequency range where inexpensive shielding may be effective in reducing it.

SPECIAL REQUIREMENTS

1. Classrooms

In the design of classrooms, it should be remembered that long, narrow rooms are less satisfactory than those which are more nearly square. Wall and ceiling construction may be designed to absorb 30 decibels of sound or more. Of great importance is the control of echo or reverberation, which may result if walls and ceilings are of a very smooth surface texture. Long reverberation can interfere with speech. Satisfactory reverberation intervals for a small room are between .75 and 1.0 seconds. Reverberation may be controlled in a room by absorptive and reflective surfaces including objects, clothes, drapes, or other soft materials. Control of reverberation is also achieved when acoustic title is applied to the walls or ceiling. It is very important that partitions between classrooms be carefully and fully closed at the top to prevent the transmission of sound in ceiling spaces.

2. Auditoriums

The acoustical design of auditoriums is a highly specialized science, and a reliable acoustic consultant should be retained for this purpose. In general, the ratio of length to width of an auditorium should be about 1.2 to 1, and the walls and ceiling should be designed to give a beneficial reflection of sound. The volume of the room should be no larger than necessary, and most auditoriums will require public address systems. There is a great difference in the acoustic properties of an auditorium occupied by a speaker only and one occupied by a speaker and his audience. In the latter instance much of the sound is absorbed by the audience.

3. Music Rooms

The sound requirements for music rooms are similar to those for an auditorium. Proper acoustic design should be provided by those who are experienced in this field. A general requirement is to avoid placing absorptive material near the music sources to enable the people who are playing to more easily distinguish each other's music. Using smooth surface floors and paneling near the player's platform is desirable for reflection of sound. The music room is a source of noise which may be disturbing to other occupants of the building. Therefore, the walls of this room should be specially designed so that sound passing through the walls is attenuated to the levels required by other occupants of the building. If the music room, together with the gymnasium lockers and/or swimming pool, can be placed in a separate wing of the school building, the major internal noise sources of the building will be set apart; and construction needed for sound shielding will be minimized. Another feature of music room construction is the so-called "splaying" of the walls and ceiling. This means that walls, ceiling, and floor are not parallel, producing a condition in which sound waves are broken up and do not reflect back in the direction they originated. As in other rooms, roughing the surface of the walls or providing soft materials within the rooms will help to absorb and deflect sound waves, and thus control the acoustic properties.

4. Gymnasiums

It is important that the gymnasium and adjacent locker rooms be as remote as possible from classrooms. Ideally, they should be located in a separate wing or, if possible, a separate building. The ceiling in gymnasium areas should be acoustically treated if financially feasible. Swimming pools are in the same category as gymnasiums, and their acoustic properties should be designed in accordance with the general requirements for this type of space.

5. Cafeterias

The cafeteria, with its buzzing, mealtime sounds, presents an acute acoustical problem. The problem may be alleviated by the use of acoustic tile on walls and celings in the dining and service areas, but the type of tile used must be cleanable. An effective material for noise control in cafeterias is suspended, perforated metal pan ceiling which may be cleaned by removal of the pans. In kitchen and particularly in dishwashing areas, the clashing of dishes, glasses, and silverware produces much noise. The room housing the dishwashing machine should be adequately sound-insulated and also be provided with ceiling surfaces of hard, sound-absorbing materials such as removable perforated metal pans. These should be made of noncorrosive material such as aluminum to prevent rusting.

6. Health Rooms

It is important that any area or room set apart for health examinations be made as quiet as possible to permit effective consultation between nurses, physicians, and patients, as well as to afford a place of quiet for patients. For this reason, health rooms should have a sound level below 45 decibels, and be located in a quiet part of the building away from gymnasium and music rooms.

Audiometer rooms should be sound treated to produce noise levels not in excess of 40 decibels and as much below that as feasible. The room should be faced with acoustic tile, and its walls designed to prevent outside sound leaking into the room. Audiometer rooms should be provided with acoustically designed doors which are available from several companies.

7. Existing Structures

It is evident that the best method for reducing noise is to build control measures into a new structure. However, if the principles discussed above are utilized, noisy situations in existing buildings may be diagnosed and corrected to a degree that will be beneficial to occupants. The sound levels existing in any room may be readily determined, and many simple steps may be taken to reduce undesirable noise.

Chapter 12
INJURY CONTROL

PUBLIC HEALTH RATIONALE

A safe school environment has a profound influence upon the lives of children. Safety, including fire safety, is the responsibility of the board of education and school administration. These groups have a moral and legal responsibility to maintain a school environment that is as safe as possible from fire and other environmental hazards. At the same time, they must offer students planned educational opportunities to develop proper habits, attitudes, skills, and knowledge related to safe and effective living. The school's responsibility for the welfare and safety of its students begins when the children leave home for classes and does not end until they return.

Accidents are the leading cause of death in the age group 1 to 38. According to National Health Survey estimates, 5,993,000 persons aged 6 to 16 years were injured during the period 1971-1972. For the same period, an average of 15,116,000 school days annually were lost due to accidental injuries.

Accidents involving school buses were responsible for 200 deaths in 1974. Of the students killed, about 35 were passengers on school buses and 55 were pedestrians either approaching or leaving a loading zone. More than half of the student pedestrian victims were struck by the school bus they were entering or leaving.

Accidents in and around schools account for a large number of injuries treated in hospitals and clinics. In addition, many unreported accidents occur which, although minor in nature, create a danger of infection and other serious after-effects.

Fire hazards constitute a major threat in schools. During 1974, 24,100 fires occurred in schools and colleges resulting in a property loss of 99 million dollars. Many school fires occur after the students have gone home, but a daytime fire, such as Chicago's Our Lady of the Angels School fire of December 1, 1958, which cost 94 lives, is evidence of the serious dangers.

When disastrous school fires occur, they deeply affect the physical, mental, and emotional health of the community. A great strain on such public resources as medical, nursing, and hospital services for emergency treatment is felt immediately. Non-fatal injuries may frequently require months, even years of treatment, with consequent strain on public facilities and finances, as well as on family and community life.

An additional consideration for administrators is the Occupational Safety and Health Act (OSHA) of 1970 which was designed to insure safe and healthful working conditions for every worker in the nation. Provisions of this Act apply to faculty and staff in all schools.

FIRE PREVENTION

1. General

Each of the following conditions is sufficiently serious to warrant discontinuing the use of existing buildings until the hazardous condition is corrected:

a. Buildings where the walls or ceilings of exit corridors are surfaced with highly combustible finishes.
b. Multi-story buildings with no means of exit other than inside stairways that lead to (1) areas with combustible walls and finishes or (2) storage areas containing combustible materials.
c. Buildings of wood construction with students housed above the second story.

d. Buildings with unventilated space below them. Gas may collect in these spaces and explode.
e. Buildings with exit doors to the outside that cannot be readily opened from the inside.

Environmental defects in design, construction, and equipment account for many school fires; nevertheless, a great number are also caused by human error, negligence, or arson. Many school fires can be traced to electrical problems, such as improper connections or overloading wiring systems. Fires may also result from improperly installed or defective equipment, especially heating or cooking equipment, and to human fallibility in using such devices.

References on environmental fire safety in school buildings are available from:

(1) National Fire Protection Association (NFPA)
60 Batterymarch Street
Boston, Massachusetts 02110

Handbook of Fire Protection (13th edition)

A Method of Measuring Smoke Density, NFPA Quarterly No. 57-9, January, 1964

Auxiliary Protective Signaling Systems, NFPA Pamphlet No. 72B, 1967

Fire Doors and Windows, NFPA Pamphlet No. 80, 1970

Incinerators, Rubbish Handling, NFPA Pamphlet No. 82, 1972

Installation of Gas Appliances and Gas Piping, NFPA Pamphlet No. 54, 1969

Installation of Portable Fire Extinguishers, NFPA Pamphlet No. 10, 1970

Installation of Sprinkler Systems, NFPA Pamphlet No. 13, 1969

Installation of Standpipes and Hose Systems, NFPA Pamphlet No. 14, 1970

Life Safety Code, NFPA Pamphlet No. 101, 1970

Local Protective Signaling Systems, NFPA Pamphlet No. 72A, 1967

Methods of Test of Surface Burning, Characteristics of Building Materials, NFPA Pamphlet No. 225, 1969

National Electrical Code, NFPA Pamphlet No. 70, 1968

Proprietary Protective Signaling Systems, NFPA Pamphlet No. 72D, 1967

Protection from Exposure Fires, NFPA Pamphlet No. 80A, 1970

Spray Finishing Using Flammable and Combustible Materials, NFPA Pamphlet No. 33, 1969

Standard Methods of Fire Tests for Flame Resistant Textiles and Films, NFPA Pamphlet No. 701, 1969

Standard Methods of Fire Tests of Door Assemblies, NFPA Pamphlet No. 252, 1969

Standard Types of Building Construction, NFPA Pamphlet No. 220, 1961

Ventilation of Cooking Equipment, NFPA Pamphlet No. 96, 1970

(2) Underwriters Laboratories, Inc. (UL)
207 East Ohio Street
Chicago, Illinois 60611

UL Building Materials List, 1971

Fire Dampers, UL Standard No. 555, 1970

UL Fire Protection Equipment List, 1971

2. Construction and Equipment

The principal elements of school fire safety are intelligent use of combustible materials, adequate exit facilities, and fire compartmenting to contain and limit fire growth and spread. Architectural design is even more important to fire safety than use of fire-resistant materials — **the most important factor is providing adequate means of escape**. There are national standards applicable to each of these elements.

School fire protection must begin with the planning of the building; it should be an essential factor in any remodeling program and it must be an integral part of all school-plant management programs. School activities should be so planned that creation of fire hazards will be reduced to a minimum.

When climatic considerations and budget permit, an ideal way to build multi-story schools is to have every classroom open into an exterior, single-loading passage or gallery. All stairs should open from the exterior side of these galleries. In this type of construction, there would be no interior corridors or stairs. In any school building, construction generally should follow the pattern below:

a. Construction should be as fire-resistive as is economically and functionally possible.

b. The building should be one story in height and never exceed two.

c. All doors opening into central corridors should be of fire-rated construction with sufficient thickness to resist the pressure of expanding hot air or gases. If possible, every classroom of a one-story school should have a door leading directly outdoors.

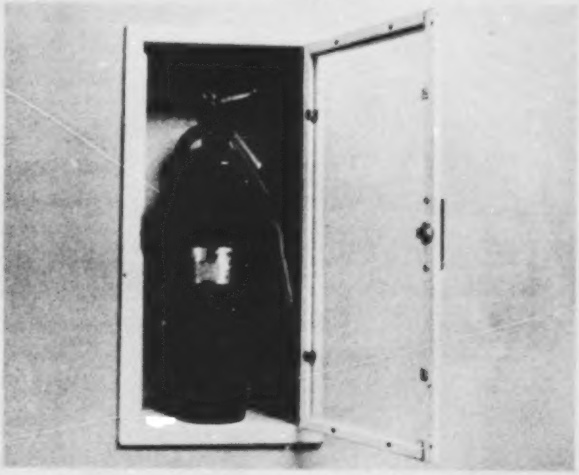
d. Exits should be easy to find and reach. There should be a main, protected, escape route and an alternate route from each occupied space in the building. Doors should be equipped with "panic hardware." A revolving door should not be used as an exit.

e. The heating plant and fuel storage room should be located preferably outside the school proper. If located within the building, these facilities should be completely enclosed by firewalls and self-closing firedoors. Heating and ventilating equipment require proper safeguards. All heating equipment should be installed in accordance with applicable standards. Fuel should be stored as recommended by the National Fire Protection Association. Paints and solvents used in art instruction should be stored in metal cabinets away from open flames and kilns.

f. Corridors and stairs should be fire resistive and should meet standards as to number, location, width, size of risers, treads, railing, and landings. Adequate provisions for the handicapped, such as ramps instead of stairs, should be incorporated into the construction (Appendix C). Unless they are properly designed and located, unenclosed stairways should be eliminated, because, in the event of fire, they often act as flues which rapidly conduct smoke, gases, and flames to upper stories. Stairs should lead directly to the outdoors, never down into a basement unless there is a direct exit there because, in panic, students may bypass the exit. Stair enclosures should be so designed that they cannot be used for storage.

g. Adequate fire protection equipment should be provided. Automatic sprinklers should be used as recommended by national and local fire codes. Fire extinguishers of the proper type should be furnished in adequate numbers and in accordance with applicable standards (Figure 18). They should be prominently located and easily accessible. Vaporizing liquid-type fire extinguishers should not be used, and any existing extinguisher of this type should be removed.

Figure 18. Approved and Easily Accessible Fire Extinguisher



h. Electrical wiring and appliances, gas piping and appliances, laboratory equipment, audio-visual equipment, and school shop equipment require special safeguards because they contain many fire hazards. Kilns should be protected from wooden walls and other combustible material.

i. Automatic fire detection equipment designed to provide prompt notification of fires in its incipient stage is desirable to enable students and teachers to escape a burning building before exits are blocked by smoke and fire. Several excellent types are available. Some are sensitive to smoke and gas, others to smoke alone or to heat or flame. Alarm systems should include manually operated stations. The fire alarm system should be separate and distinct from the regular signal system. Fire alarm gongs and warning devices should have a tone different from other alarm signals in the building. A separate recall signal should be used so that students will not mistakenly re-enter a burning building. If possible, fire alarms should be of the type activated by a detector with indicator in the nearest fire station.

j. Elevator shafts and any other floor openings that would allow fire to spread from story to story should be enclosed with fire-resistive enclosures.

k. In the event of fire, means should be provided for quickly shutting off fans in the ventilation and air-conditioning system. Smoke detection devices placed in the ducts are desirable in larger buildings.

l. In the event of fire, windows may be a last resort of escape; nevertheless, they should be large enough to permit egress by occupants and should be operable and within reach of those occupying the room.

3. Inspection and Housekeeping

Most State laws require a system of periodic fire safety inspections for structural and other defects in all school buildings by either the State fire marshal or local fire authorities. Self-inspections by local staff, periodic inspections by the fire department and the rating bureau, and such special inspections as are needed or can be provided by boiler and electric wiring technicians are in order. Other outside assistance might include insurance inspection bureaus and local representatives of fire and casualty insurance companies. Public health authorities, including environmentalists, usually have the authority to require that schools within their area not contain hazards to the health and safety of children, and may be required to inspect school buildings periodically. The ultimate responsibility rests with the superintendent of schools and his school board.

All such inspections should be followed by written reports which serve as a basis for making corrections and for protecting local school officials. Where needed, rehabilitation programs should be planned to correct existing defects. Where defects cannot be corrected in existing buildings because of their nature or cost, the buildings should not be used.

No school building, no matter how well planned and constructed, is entirely free from the hazards of fire. Even fire-resistant buildings will contain combustible material. Good housekeeping and maintenance cannot be overemphasized and call for the highest level of performance in such tasks as cleaning, rubbish and waste removal, incineration, storage of combustibles, selection and care of decorations, handling of ashes, maintenance of electrical equipment, and handling of flammable liquids.

Sprinkler systems, fire equipment, and alarm systems require rigorous and frequent inspections.

The school administration staff should organize and direct thorough fire-inspection programs within the school, and the teaching staff should assume responsibility for safe conditions in their areas of operation, being alert to fire hazards throughout the buildings as well as in their classrooms. The custodial and maintenance staff should be responsible for making certain inspections and should participate in planning for fire safety.

The principal, custodian, students, and teachers all have a responsibility for insuring proper storage of cleaning materials and furniture and seeing that nothing is placed either temporarily or permanently on stairs, or in halls, corridors, or exits.

4. Supervision and Education

Protected exits must be plentiful and readily available, alarms given instantly when threat of fire is discovered, and the building emptied immediately. Education in fire safety is, therefore, a necessity.

Protective features built into buildings and a reasonable fire-safe environment are not enough to protect school children if, in emergency, they and the adults in the building — principal, classroom teachers, visiting teachers, custodians, school nurse, cafeteria, and other employees — do not know thoroughly the procedures required for emergency action or do not have periodic opportunities to practice these procedures and to review how well they work in practice drill.

A program of fire drills should be set up to provide for all probable emergencies to insure, in the event of fire, the safety of all persons when leaving the building and to make fire drills as nearly automatic as possible. A system for reporting fires must be established and an educational program set up to train every teacher and student in what to do in the event of fire.

SAFETY

1. General

Many factors must be considered in evaluating a school environment for safety. These include the selection of the school site, student transportation and motor vehicle safety, proper construction, and maintenance of the buildings and playgrounds, and safe practices followed in the buildings and on the grounds. Some facets of safety in the school environment are mentioned in other chapters, but because of their importance, they may be re-emphasized in this chapter.

A safe school environment is dependent upon the community's willingness or ability to provide a site, structure, and equipment that conform to adequate safety standards, and to establish appropriate safety measures. The school administration necessarily assumes responsibility for making these needs known to the community and for supervising adequate maintenance.

Structural safety in design of the school plant is the responsibility of the architect. Local and State building codes usually regulate construction of foundations, walls, roofs, electrical wiring, internal finishes, exit doors, plumbing, and heating equipment.

Building contractors must follow through with sound construction policies. Installation of strong and safe basic equipment is essential. However, none of these can insure a safe school environment unless maintenance standards are high and supervision vigilant. A particularly different problem is how to increase safety features in existing buildings by modifications where replacement is not feasible.

2. Site

a. Prior to site selection for a new school, a check should be made with the State Highway Department about new highway or expressway routes, and with the Federal Aviation Agency regarding new or expanding airport facilities which may be planned. In cases of older schools, where some of these location hazards cannot be eliminated, hazards should be mitigated by overpasses or underpasses, by fencing, traffic control devices, or by alteration of traffic flow. It may be advisable and necessary to relocate the school.

b. Location in industrialized areas or near main highways, railways, or take-off and landing paths of airports should be avoided.

c. The school site should be away from sources of dust, smoke, gases, and heavy, unpleasant odors such as alfalfa plants, feeding lots, cement works, refineries, above-ground storage tanks, and other hazardous or distracting conditions.

d. Grounds should be as level as possible, except where certain terrain features are necessary as acoustical barriers. Hilly or sloping grounds requiring retaining walls or terraces multiply the hazards to students. Grounds should be cleared of all obstructions, stumps, stones, accumulation of trash, open pits, and anything else that might cause injury. Weeds must be regularly cut to prevent a coarse stubble from developing. All poisonous plants should be cleared from the area. Proper grading to drain off surface water is essential.

e. School sites should also be adequate in size and shaped to provide maximum playground space. Ground areas of extremely small sites are generally overcrowded and recreational opportunities limited. Foresight is required to anticipate needs for possible expansion in the future.

f. All playgrounds should be protected from adjacent streets, service roads, and parking areas by substantial fencing. They should be enclosed by strong, durable fencing of woven wire or equivalent material, with a minimum height of 8 feet. Material should be such that it will not injure the child who comes into contact with it. It is desirable to have the playground located immediately adjacent to the school building and to provide a separate play area for smaller children. Surfacing of playgrounds should permit use in any weather and should not be too abrasive. Grass is generally considered to be an ideal surface material for playgrounds, but where this is not possible, smooth asphaltic surfaces are considered adequate. Blacktop also provides an all weather surface; it absorbs heat, causes snow to melt rapidly and water to evaporate quickly, and is resilient. A level surface, except for drainage needs, is best for playgrounds where children are involved in organized games or group activities. The sections to be used for particular types of activities should be separated in a way to avoid interference.

g. Many accidents occur around fixed playground equipment. This may be partly because the equipment is incorrectly placed; it may also be due to incorrect installation, poor maintenance, or inadequate supervision. Playground equipment should be carefully selected and properly placed; major equipment should be located out of the natural pathways of traffic. Playground equipment should have supports of galvanized or painted metal, and be firmly anchored in cement. Erosion around these footings should be corrected and prevented. See-saws should have guards to prevent the boards from hitting the ground. Steps leading up the slides should have handrails. Swings offer special hazards which can be minimized by using seats of lightweight material such as belting, rubber, or heavy canvas. Whatever the type of apparatus, careful instruction in its use, as well as in matters of courtesy, caution, and consideration for others, will reduce injuries. Close supervision of students during play periods and regular maintenance of equipment will keep accidents at a low rate. A good reference on playground safety is *Play Areas,* published by the National Safety Council.

h. When placed under playground equipment, some non-packing material such as sand or sand and sawdust will help break the impact of a fall. Other materials may prove more desirable, however, depending upon availability, climatic conditions, cost, cleanliness, etc. Whatever the material, it should serve to minimize injury from falls.

i. Swimming pools should be equipped with decks of non-slip ceramic tile or of concrete with a non-slip finish and easily accessible ladders on all sides. Diving boards should have a non-slip surface. Life saving equipment should be furnished and lifeguards should be on duty whenever the pool is in use.

3. Student Transportation and Motor Vehicle Safety

a. The school and its playgrounds should be in clear view when approached from any direction. If this is not possible, effective warning signals should be erected so that they can easily be discerned by motorists and others. All intersections and crossings should be marked with the proper traffic control devices. Appropriate speed limits should be well marked and enforced on school property.

b. Police, adult crossing guards, or school safety patrols should be on duty at crossings and intersections adjacent to the school in the morning, at recess, and at close of the school day.

c. Provision should be made for safe loading and unloading areas for children who are being transported to and from school. Loading areas should be designed to avoid the need to back schoolbuses or cars on school grounds.

d. Schoolbus drivers should be carefully selected, trained, and properly licensed prior to transporting students. Periodic safety instruction should be provided to all drivers to insure current knowledge of safe driving habits and emergency procedures.

e. Provision should be made for frequent routine inspection and maintenance of schoolbuses and safety equipment by competent mechanics to insure safe operation. An inspection of the vehicle's exhaust system should be conducted periodically to avoid the hazard of carbon monoxide poisoning.

f. A parking area, a large play area, a bicycle area with bicycle racks, loading areas for schoolbuses and private cars, service areas, and pedestrian walks should be available and adequate. Each of these areas should be separated from the other and arranged so that each individual area is accessible without passing through another.

g. The service driveway should be planned so that trucks and other vehicles will not cross the play areas or in other ways create a hazard to the safety of students. This driveway should lead from the street to the school only, not through the school area to another street.

h. All streets approaching schools should have sidewalks.

i. Walkways adjacent to the building wall should provide a minimum of a 6-foot overhead clearance of any projection that opens by swinging or tilting outward from the building. Walkways should be placed 15 feet away from the wall of the building in areas where there is danger of heavy snow slides from the roof. Steps at or near outside doors should be eliminated if possible, and walkways leading from outside doorways should be level with the floor within the doorway.

4. Building and Equipment

A school building should be well proportioned, substantially constructed, and fire-resistant. Walls and foundations should be in good repair, free from cracks or other evidence of failure under stress. Floors should be flat and firm; and general plumbing, electric equipment, and other furnishings of standard materials should be adequately installed. Some factors important in insuring safety in the school building environment are the following:

a. Fire safety must be achieved. This was discussed earlier in this chapter.

b. Plumbing, lighting, and ventilating systems, considered in other chapters of this publication, have many safety features.

c. All floors should be level. In fire-resistive buildings floors are usually concrete and should be covered with resilient tile in classrooms, laboratories, offices, auditoriums, and corridors. All floor coverings should be of a non-slip type, and waxes used should have non-slip characteristics. Toilet rooms and showers should have non-slip finish ceramic tile on floors. Kitchens should have quarry tile floors.

d. Steps should be eliminated wherever possible. Gradual ramps are preferable to steps. Treads and risers should be uniform throughout the building and should conform to acceptable standards. Tread surfaces should be of the non-slip type. Handrails low enough for young children to use should be provided on both sides of the stairways and ramps. Provisions for the handicapped must be considered in this regard.

e. Locating drinking fountains and other equipment in recessed areas, flush with the wall, can eliminate many hazards.
f. School furniture and equipment must be adequate and safe. Furniture which fits the child should be provided in every room. Edges should have rounded corners. Machines and equipment used in shops, laboratories, and cafeterias should be supplied with approved safety appliances. Apparatus used in science laboratories requires special attention for safety precautions.
g. Multi-purpose rooms and gymnasiums must be adequately designed and supplied with appropriate safety equipment, such as rubberized interlocking mats.
h. Doors from classrooms or other student occupied rooms should enter the corridor between exits or there should be direct egress to the outside from the room.
i. Windows which swing or tilt inward into a classroom should have an overhead clearance of at least 6 feet.
j. Corridors should be adequately lighted, especially near stairs, doorways, and drinking fountains. They should contain no projections or other obstructions.
k. Where glass is used in doors or walls, safety glass should be installed.
l. All schools should have a telephone on the premises to call for assistance in emergencies, with appropriate numbers clearly posted near the phone.
m. Firesafe storage areas for extra books, tools, supplies, folding chairs, occasional furniture, maintenance and cleaning supplies, etc., should be built into the structure. Metal containers should be used for all flammable liquids. Metal trash receptacles for classrooms, offices, and for bulk collections of trash should be provided.
n. The provision or designation of areas which will provide shelter against radioactive fallout should be carefully considered. The Office of Civil Defense offers architectural and consulting engineering firms advice and guidance in the techniques of including public fallout shelters in the design of new buildings or of modification and expansion of existing ones.

5. Special Areas

Special planning is necessary for the facilities and equipment in the stage area of the auditorium, in the cafeteria, and in special purpose rooms and areas. Solidly built risers or tiered platforms for music group activities, storage for stage properties, and locked covers or doors on electrical control panels are required.

The school shop should have adequate lighting, especially around power-driven machinery. Power machinery guards should be provided and used. Power machines should be located away from major traffic-ways, and if necessary, fenced off. Power machinery should be controlled by key switches. Equipment, shelf and closet space, etc. should be provided and arranged so that it will be easy to keep the area clean and neat.

The art and industrial arts areas are potentially hazardous. Precautions must be taken to avoid injury to children, with attention to the special problems of sharp tools, power tools, ceramics, paints and solvents, wood sculpture, and welding. Appropriate safety instruction, good supervision, and safe work and storage areas should be maintained for each of these activities.

Science laboratories may present special hazards if chemicals and solvents are not properly stored and handled. Adequate ventilation should be provided and every student should have access to a sink and an emergency shower. An adequate, efficiently planned storage room is essential for the laboratory. The storeroom should not contain blind alleys and should have a well-marked exit, be properly ventilated and lighted, and should be arranged to segregate incompatible chemicals. Volatile and flammable solvents should be stored in safety cabinets which comply with Occupational Safety and Health Administration (OSHA) specifications. Order and cleanliness should be maintained. Adequate safety equipment should be provided for all students and faculty, including aprons, gloves, and safety goggles or glasses; and wearing them should be mandatory.

Care must be taken in the disposal of laboratory wastes. Combustible chemicals and volatile liquids should be cleaned up immediately after they are spilled. Wastes should be segregated in clearly marked refuse cans to prevent unwanted chemical reactions.

6. Radiation

CAUTION
RADIOACTIVE MATERIALS

Any school intending to use radioactive materials other than radium must obtain from the Nuclear Regulatory Commission a license for each location where the materials will be employed. Each individual license specifies the kinds and quantities of materials authorized for use. Subsequent disposal of all radioactive wastes must be handled in accordance with the regulations of the Nuclear Regulatory Commission.

a. School authorities should recognize the hazards associated with the use of radiation, both to students and teachers.
b. There should be awareness of the radiation-producing capabilities of such machines as small "particle accelerators," "fluoroscopes," etc., used in science demonstrations, some of which yield a relatively large radiation output.

Laboratories or other areas in which unsealed radioactive materials are to be used should be equipped with suitable contamination control equipment such as secondary containers, trays, and tongs. Work surfaces should be protected, and labeled tags or stickers used as required. Suitable radiation detectors should be readily available, and the teacher should be trained in their use and interpretation.

Sealed sources used for demonstrations should be kept in suitable shielded containers which can be locked. Those using such sources should be familiar with the radiation levels associated with their use and the precautions needed to reduce both student and teacher exposure.

Many small "particle accelerators" used in science demonstrations produce significant radiation levels, of which the user is frequently unaware. All such apparatus should be checked for stray radiation prior to its use in a class and, if necessary, adequate shielding provided during its employment.

7. Maintenance

When a school building has been provided with maximum safety features, the school authorities cannot consider their job done. Actually, the maximum degree of safety in school buildings and premises can be obtained only through adequate maintenance. No matter how well a structure has been planned and constructed, it deteriorates in time and without proper maintenance hazards increase. Some examples of hazards caused by poor maintenance include: highly waxed or polished floors and stair treads, failure to change air filters, storage of combustibles in spaces not designed for such materials, use of attic space for storage, insufficient illumination for stairways and other areas where falls may occur, use of flammable curtains in auditoriums, worn and slippery walkway surfaces, loose handrails, accumulation of trash in dangerous quantities, improper maintenance of playground equipment, and dangerous levels of carbon monoxide when fuel burning equipment is not properly maintained and vented.

Periodic inspections throughout the year are required to insure maximum safety. The school superintendent, in cooperation with the custodian, building superintendent, a member of the board of education or members of the local fire and health departments, should constantly endeavor to ascertain the extent to which the safety of pupils is being insured. Maintenance is a responsibility also of the building engineers, the principal, classroom teachers, all other adult employees using the building, and the student.

Chapter 13
SOLID WASTE MANAGEMENT

PUBLIC HEALTH RATIONALE

Improperly stored or handled solid wastes can harbor or attract disease-carrying arthropods and rodents. These materials can create fire and other safety hazards as well as an aesthetically unacceptable situation.

GENERAL

A well designed and efficiently operated system for the prompt collection and disposal for all solid waste materials originating on the school premises must be provided. There are three components of the solid waste management system: collection and storage, removal, and disposal. Considerable progress has been made in improving the solid waste management systems in schools. However, continued surveillance and close monitoring of the systems are necessary to prevent problems.

COLLECTION CONTAINERS

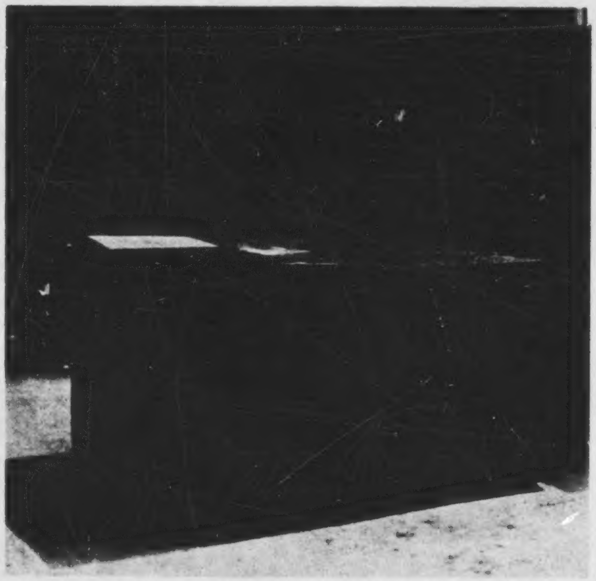
Each classroom should be provided with a sufficient number of waste baskets. These baskets should be constructed of sturdy, durable material such as fiber board, plastic, or metal. The containers should be emptied daily and should be kept clean. In special areas such as a cafeteria, covered refuse containers should be provided.

The use of disposable liners for waste containers can substantially increase the sanitation of solid waste handling. Where 20-gallon corrugated metal cans or other approved cans are used for garbage collection, they should be cleaned daily (provided plastic liners are not used). This cleaning should preferably be with a steam cleaner, but in the absence of a steam cleaner, cleaning may be accomplished by the use of adequate quantities of warm water, a detergent, and a strong bristled brush. Waste water from this activity should be disposed of in an approved manner. Adequate storage containers, usually located outdoors, must be provided for emptying waste baskets and other waste containers. When cans are used for storage, they should be placed on racks above ground.

Commercial-type bulk containers are frequently used (Figure 19). These containers also should be cleaned at frequent intervals to prevent their becoming sources of odor or breeding places for insects or rodents.

Care should be taken to see that cans or bulk containers are covered at all times to prevent fly and rodent attraction. Some bulk containers

Figure 19. Commercial-type Bulk Refuse Container and Well-maintained Refuse Storage Area



have slanting sides so that waste may pour out unassisted when lifted and tilted by a truck. These containers are threatening because of their tendency to topple onto users or students at play, especially when placed on uneven ground. Unstable bins should be prohibited, and safe use procedures should be required. Students should not be allowed to play around refuse storage areas.

Screened enclosures for storing refuse cans are not recommended as they tend to become large fly traps.

INTERNAL COLLECTION SYSTEM

An internal collection system should be organized within the school to provide for the regular emptying of refuse from waste baskets, waste cans, or other containers. The collection system should be designed to prevent the spread of contamination. The traveled collection route should be as direct as possible from the point of origin of waste materials to the point of storage on the school premises. Internal collection routes should also be designed to avoid crossing corridors or areas frequented by students, especially when collection is necessary during school hours.

POINT OF DISPOSAL

The best method of solid waste disposal is to have it collected and disposed of by a public system, if the system is satisfactory. If public collection is not available, the school is faced with disposing of the refuse with its own equipment or contracting with a private disposal firm for collection and disposal services. Schools can dispose of their refuse by (1) hauling the material to an approved disposal site, (2) onsite grinding with discharge to the sewer, and (3) onsite incineration of combustible wastes. A portion of the refuse will always require disposal off the school premises.

From a public health point of view, garbage grinding is an excellent method of disposal because it is convenient, sanitary, and eliminates storage and handling problems. However, the effect of garbage grinding on the sewage disposal system must be taken into account. A number of cities prohibit installation of grinders because sewage disposal facilities are inadequate.

Incineration of combustible materials may create air pollution problems if the incinerator is not designed or operated properly. The cost of a suitable incinerator depends to a great extent upon the size of the school and the type and quantity of refuse burned. Often the cost is prohibitive. The State agency responsible for air pollution control should be consulted regarding design criteria and emission standards.

RECYCLING

A high percentage of the solid waste generated by schools is paper. In areas where it is economically feasible, efforts should be taken to recycle paper and other materials.

Chapter 14
ARTHROPOD AND RODENT CONTROL

PUBLIC HEALTH RATIONALE

A substantial number of human diseases are transmitted or caused by arthropods and rodents. The damage by insects and rodents to school property each year amounts to millions of dollars. Their presence may also indicate the existence of serious environmental deficiencies.

GENERAL

The complex structure of modern schools makes it highly unlikely that all potential harborage places for arthropods and rodents can be eliminated or that access can be denied permanently. However, it is possible to maintain a school plant and premises in such a condition that populations of arthropods and rodents can be maintained at low levels. There are three fundamental methods for achieving this control: (1) good sanitation throughout the school premises, (2) the proper use of insecticides and rodenticides, and (3) structural measures. The third measure includes the general maintenance and care of buildings and prompt repair of cracks which appear in exterior or interior walls, denying access to arthropods and rodents.

BASIC SANITATION

The best means of preventing an infestation is to maintain good sanitary standards throughout the school plant and premises. Areas especially favorable to arthropod rodent populations are cafeterias, lunchrooms, kitchens, toilets, washrooms, basements, storage rooms, and locker rooms. Concerning locker rooms, students should be continuously instructed on the importance of keeping their locker clean, free of food and soiled clothing.

Basement areas where fuel supplies and tools are stored, and where the heating system is located, are natural places for arthropods and rodent harborage. The custodian's operations should be checked at regular intervals to insure that basement rooms are kept in a litter-free condition. An important aid to maintaining sanitary conditions throughout the school plant is the provision of good lighting. Methods for achieving lighting and lighting standards for different types of occupancy are described in Chapter 9.

The kitchen and dining areas present special problems in arthropod and rodent control. Food should be stored in containers with tight-fitting lids. After each meal, the entire kitchen area should be thoroughly cleaned. Proper handling and storage of garbage is mandatory.

Washrooms and shower rooms should be thoroughly cleaned to remove accumulations of dirt, particularly in the corners. Areas under lockers should be swept frequently or vacuumed.

No deposits of trash, brush, wood, or other material which may provide harborage for rodents should be allowed to accumulate on the premises outside the school building.

Spillage of garbage on the soil can be a source of fly production and should be avoided. The eggs of domestic flies hatch in 12 to 24 hours, and the three larval stages usually last from 4 to 7 days in warm weather. To prevent migration of fly larvae from garbage cans and bulk containers to pupate in the ground or under debris, refuse should be removed from the premises frequently.

Standing water, both surface water and that collected in artificial water holding containers, is conducive to mosquito breeding and should be drained or otherwise protected to prevent this problem.

PESTICIDES

Pesticides such as insecticides and rodenticides should be considered as an ancillary aid to the control of arthropods and rodents. Persons intending to utilize pesticides should be aware of the major provisions of the Federal Environmental Pesticide Control Act of 1972 and its amendments. The Act specifies that pesticides must be classified for "general" use or "restricted" use by October 1976. Those placed in the restricted category may be used only by, or under supervision of, certified applicators. Standards for Federal certification of pesticide applicators have been established. To be certified, an individual must demonstrate that he is competent in the use and handling of pesticides.

The Act also states that the use of any registered pesticide in a manner inconsistent with labeling instructions is prohibited. Label directions and precautions on all pesticide products registered for sale are designed to prevent injury to man and the environment. Additional information may be obtained by contacting local and State health departments and State agriculture departments.

Arthropods sometimes encountered in the school or on school premises include flies,cockroaches, ticks, lice, and mites. Mosquitoes and ants may occasionally become a problem in some areas.

The housefly, *Musca domestica*, is the domestic fly most commonly encountered in the school environment. The breeding sites of these flies include animal wastes, refuse, and other organic debris so that control with chemicals is effective only when combined with proper sanitation measures. The housefly has become resistant to many of the organochlorine and organophosphorus compounds formerly used in its control. Such resistant populations also are frequently less responsive to carbonate and pyrethrum-type materials. The resulting reduction in choice of effective chemicals accents the fundamental necessity of improving environmental sanitation as the primary control means.

Because cockroaches frequent areas where food is prepared or served, precautionary measures must be taken during the insecticide treatment to avoid contamination of food or food preparation surfaces. In treating the school cafeteria with a residual insecticide, the toxicant should be applied as a spot treatment. The spot spray should be used to treat baseboards, cabinets, along waterpipes, under refrigerators, behind stoves, and other cockroach harborages. To obtain a quick kill in heavy infestations or to drive the insects from protected areas, a pyrethrum aerosol should be used just prior to the residual treatment.

Dust applications offer an advantage over liquid treatment in that they give better penetration of enclosed areas, such as beneath cabinets and in wall voids. Their use in visible areas is normally precluded because of their unsightly appearance. The drift qualities of dusts enable them to be used in any area that is difficult to spray. A disadvantage, however, is that cockroaches tend to avoid dust deposits. Certain dusts containing fluoridated silica aerogels are reported to act as a desiccant as well as a repellent to cockroaches.

Ticks may be encountered in wooded areas on or near school premises during some seasons of the year. Control of stray dogs on school premises will reduce the likelihood of infestations of the brown dog tick. Five-foot-wide band treatments around foundations may prevent ticks from entering. Area control can be obtained by applying suspensions, emulsions, or dust formulations of appropriate pesticides. Great care must be taken to avoid contamination of waterways if area control methods are utilized for tick control.

Scabies, or "the itch" as it is commonly called, has been reported among school children in many states in recent years. The disease, caused by a microscopic mite, is spread by transfer of the adult mite from an infected individual to another person. Mites are usually passed by close personal contact; transmission on fomites (towels or clothes) is frequent. Spread within households is much more frequent than in classrooms or offices. The first symptom of scabies is itching over much of the body, especially at night.

If scabies is diagnosed, the affected individual and his or her household contacts should be treated. Affected individuals should be referred to a physician. Bed linen and clothes can be disinfected by normal laundering in hot water. An appropriate chemical spray formation may be used for treating other potential fomites not amenable to laundering. Current recommendations for treatment should be obtained from health authorities.

In the United States, problems with head lice have occurred frequently in recent years, particularly among school children. Head lice are transmitted through direct contact with an infested person and indirectly by contact with their personal belongings, especially clothing and headgear. Although commercial shampoo and lotion preparations are available for treatment, medical or health department personnel should be contacted for appropriate recommendations. Important preventive measures involve laundering of clothing in hot water (140°F for 20 minutes) or dry cleaning to destroy nits and lice, frequent changes to properly laundered clothing, and personal cleanliness.

Successful rodent control can be achieved only by diligently practicing proper food storage, refuse storage, collection, and disposal, harborage elimination, and ratproofing. The use of traps and rodenticides, either alone or in combination, are supplemental to and not a substitute for effective sanitation.

Trapping is the least efficient method, because it eliminates only a small percentage of the total rodent population. Trapping does prevent odor problems that may occur if a poisoned animal dies within walls, floors, or ceilings.

Rodenticides fall into two categories: the single-dose type which is fatal to the rat through a single feeding (e.g., zinc phosphide, red squill) and the multiple-dose type which requires repetitive feedings to be effective (e.g.,warfarin, diphacinone). The latter type has dominated the field of rodent control for more than a decade. These slow-acting rodenticides are used in most situations because of their effectiveness and low risk to humans and domestic animals.

Multiple-dose anticoagulant rodenticides can be used as a liquid or dry bait. Dependable control of the Norway rat and the roof rat generally can be accomplished with these rodenticides. Because of the discovery of widespread resistance, it is apparent that present practices of relying continually on anticoagulant baits in rodent control should be modified. One approach that has been suggested would be to place greater emphasis on good sanitation practices and to use the anticoagulants only when needed.

The single-dose rodenticides are especially useful for the rapid reduction of large populations of rodents. This type generally requires fewer man-hours to apply and less bait material. Most single-dose rodenticides should not be used in a school because of high toxicity and higher than average risk of exposure. Appropriate health authorities should be consulted for use recommendations.

Control of mice sometimes can be accomplished by the use of anticoagulant baits. Because mice do not forage widely, the use of many well distributed small baits is preferable to a few large ones.

When rodenticides are used, a chart should be prepared to show the exact location of the baits. This route should be checked at regular intervals after application to replenish the baits and to remove any dead rodents near the bait station. The baits must be located in areas not easily accessible to students.

STRUCTURAL METHODS

Arthropods and rodents should be denied entrance to a school plant by closing unnecessary access openings. All new buildings should be required to be of rodent-proof construction. Existing buildings should employ necessary rat stoppage techniques to block all passages by which rodents are likely to enter or exit the building. It is possible to achieve rodent stoppage in a variety of ways, such as covering air spaces with hardware cloth, sealing cracks and holes with concrete or metal, constructing concrete curtain walls or using a combination of these and other ways. Reference for details should be obtained by consulting local and State public health agencies.

It is most important in the structural method of arthropod and rodent control that the school plant be kept in good repair. When cracks appear in walls, they should be promptly closed and damage to screening should be repaired. Hard surface cover of crawl spaces with a thin concrete slab or layer of asphalt will help prevent the entrance of rodents. Rat-proof floors are recommended in food preparation and storage areas.

Chapter 15
GENERAL HOUSEKEEPING AND MAINTENANCE

GENERAL

Modern housekeeping is rapidly becoming a science which has gone beyond mopping or sweeping of rooms, although these procedures are still an essential part of the program. For this reason, the person who is in charge of housekeeping or custodial care should be carefully selected. The usefulness of a housekeeper in the school system will be enhanced if the position is recognized as one of importance and includes a salary commensurate with the product which is anticipated.

Arrangements should be made to provide the housekeeper in-service training, which can in part be accomplished by visits to other schools. It is also desirable that the custodian participate in training sessions such as those that may be given by a State college or university. This individual should also be provided with suitable periodicals which will provide up-to-date information on house cleaning methods and materials.

A workroom separate from the furnace room, storage space for outdoor machines and tools, and service closets with a mop sink or a mop shower should be provided for the custodian. Space for mops and brooms should be provided on each floor of the building. Most schools will also require a workshop room for the custodial-maintenance personnel. The size of the school will determine the number and location of such spaces. They should be located so as to minimize custodial travel. In addition to a central workroom, the custodian should have convenient office space for the filing of reports, preparation of orders, and completion of other necessary paper work. Such rooms should be kept clean, not only for aesthetic reasons, but to eliminate food and harborage for insects and rodents and to prevent fire hazards.

SCHOOL ADMINISTRATION'S RESPONSIBILITY

1. Insure that plans for all new construction include adequate, properly lighted and ventilated areas for custodial supplies, including cleaning material and equipment.

2. Provide a sufficient number of mop sinks in suitable locations (at least one per floor and one per wing).

3. Provide the necessary cleaning supplies and equipment for custodial staff.

4. Develop, with custodial staff, a cleaning and a maintenance schedule.

5. Supervise the custodial operation, insuring that proper cleaning and maintenance are performed according to prepared schedules.

6. Insure that custodial-maintenance staff have adequate knowledge and skill to carry out all assigned duties.

DUTIES OF CUSTODIAL STAFF

1. Maintain an environment conducive to the general safety, health, and comfort of teachers and students.

2. Maintain grounds in a clean, safe, attractive manner.

3. Maintain cleanliness of the building, facilities, and equipment.

4. Promote fire safety through preventive actions.

5. Operate the service systems, including the lighting, heating, cooling, ventilating, water and sewage systems.

6. Order, inventory, and insure proper storage of cleaning and maintenance supplies and equipment.

7. Develop, with administration staff, cleaning and maintenance schedules and review these schedules periodically.

8. Maintain all records pertaining to custodial duties and report as required.

CLEANING SCHEDULE

No one cleaning schedule will be appropriate for all schools. Particular cleaning jobs, however, need to be done daily, weekly, monthly, or occasionally. Appropriate procedures should be outlined for each school. Also, any schedule should allow for non-routine and unexpected work that may be required.

HOUSEKEEPING PROCEDURES

1. General

Directions and Procedures for all cleaning should be written out, and should include:

a. Proper use of cleaning tools and equipment.

b. Proper use of cleaning compounds. Note: **Read labels and follow directions of manufacturer for all products.**

c. Care of tools and equipment such as cleaning and drying mops, cloths, and brushes; and the preventive maintenance on equipment as per manufacturer's instructions.

2. Toilet Rooms

Toilet rooms should be cleaned at least daily, and possibly more than once a day in heavy use situations. All units, including water closets, sinks, urinals, and floors should be cleaned and disinfected daily. Hand towels and soap should be replenished as needed during the day.

3. Floor Maintenance

a. Concrete floors

Concrete floors are common in school buildings, but they have a tendency to dust or pit. When pits are noticed, they should be repaired promptly to avoid development into larger indentations or cracks. Where dusting of concrete floors is excessive, the floors should be scrubbed at intervals with a neutral soap. If dusting persists, they should be scrubbed with steel wool and again cleaned with a neutral soap. After the floor has been rinsed and dried, it should be coated with a sealer or hardening material. If sealing coatings wear off because of heavy traffic, the floors should be resealed. It is unnecessary to reseal floors at frequent intervals along walls or in other areas where there is little wear. Another method of dust prevention is the use of a thin coat of non-slip wax. If the concrete floor is badly worn or pitted, it should be refinished with a substantial layer of new concrete.

The painting of concrete floors is sometimes effective in improving sanitation and housekeeping. However, on basement floors where moisture penetrates the slab from beneath, maintaining a painted surface will be difficult. For best results concrete paints should be used, and the atmosphere of the room in which painting takes place should be dry. Some paints containing abrasive materials and others with phenolic resin bases have been quite successful. Rubber-base concrete paints are good since they are resistant to both alkalis and water.

Prior to painting concrete surfaces, they should be thoroughly cleaned and all oil and grease removed with solvents. Old paint and wax should also be removed, and rough spots should be sanded down to a smooth surface. An extremely smooth concrete surface should be slightly roughed before painting by scrubbing with a 10 percent solution of hydrochloric acid. The floor should first be dampened, wet with an acid solution, and then scrubbed with a fiber brush. The floor is then ready to be rinsed thoroughly with clear water, dried, and painted. New concrete should not be painted for at least 6 months after installation.

Manufacturers' directions for the concrete paint selected should be followed, and it is desirable to use several coats. Four to five days should be allowed for complete drying, followed by the application of a thin coat of non-skid wax.

b. Terrazzo floors

Terrazzo, a mixture of cement and marble or cement and granite chips is maintained similarly to concrete. No acids, abrasives, or strong alkaline cleaners should be used on terrazzos. Floors of this type should be sealed with a penetrating-type sealer and cleaned with neutral soaps and a damp mop. Some synthetic terrazzo floors may be kept in good condition by occasionally wiping with a neutral oil, such as one containing equal parts of raw linseed oil and kerosene or turpentine.

c. Tile floors (ceramic)

Use of heavy soaps should be avoided in the care of ceramic and ceramic-type floors. Neutral soaps or mild detergents should be used, and the floors should be damp mopped. Following cleaning, the floor should be rinsed with clean water.

d. Tile floors (rubber or vinyl)

Rubber or vinyl floors can be cleaned with a dust mop. They should be wet mopped occasionally with clear water or a mild solution of trisodium phosphate or synthetic detergent. Neither turpentine, petroleum base waxes, nor sweeping compounds should be used in the care of rubber or vinyl tile floors. Likewise, shellac, lacquer, and varnish should not be used on such floors. Floors of this type can be kept from becoming dented by using glides or wide rubber casters underneath furniture legs.

e. Tile floors (asphalt)

Ordinary asphalt tile floors are not resistant to grease, oils, spirit-solvent waxes, kerosene, gasoline, and turpentine. They should be damp mopped occasionally with a warm water and neutral soap solution, then rinsed with clear water and dried with a clean mop. Stains may be removed by rubbing lightly with number 00 steel wool and a concentrated solution of neutral soap and warm water. Asphalt tile floors will take water emulsion-type finishes and resins or plastic-type floor finishes.

f. Magnesite floors

Magnesite is a form of concrete and requires care similar to that for concrete.

g. Cork floors

Cork floors should be cleaned by sanding them lightly with steel wool and applying a light water emulsion wax. It is important to keep the floor dry and free from grease, strong chemicals, or agents which may stain.

h. Wood floors

Wood floors installed in school buildings vary but usually include northern hard maple, beech, and birch. In some areas, red oak and white oak are used, but where traffic is heavy, this wood may splinter, producing a surface which cannot be easily cleaned. All wood floors should be carefully finished following installation. Commercial sealing agents are available. When applied, fine finish should penetrate below the top of the surface of the wood, seal the pores, not stain, reflect light, be non-slippery, not be subject to excessive marring, scratching or flaking, be water-resistant, and be of such nature that foot traffic will not mar a uniform appearance.

4. Housekeeping of Floors

Classroom floors should be swept daily or more often if necessary. Brushes from 16 to 18 inches in width may be used for ordinary floors. Brushes having short, coarse bristles do not sweep well, but leave dirt streaks. Brushes should be retired when they become worn. Sweeping compounds may be used on rough or untreated surfaces (except rubber or vinyl tile), but not on treated surfaces. In sweeping stairs, brush strokes should be parallel to the length of the stair tread rather than across its width. Vacuum cleaning equipment should be used for cleaning operations wherever possible.

In scrubbing and damp mopping floors, excessive use of water and the wrong kinds of cleaners will be detrimental. It is wise to obtain advice from reputable manufacturers in the choice of cleaning agents. Water used to clean a wooden floor should not be allowed to remain long, as it will damage the wood. Damp mopping is recommended for linoleum, asphalt, plastic, or rubber tile. A good type of mop is one made of cotton yarn, 20 ounce weight for general purposes and 16 ounce for small rooms. Each person who is given the job of cleaning should be provided with a mop-and-wringer pail or two pails, one containing water and a neutral soap or mild detergent and the other clean water for rinsing. Before a floor is cleaned, spots of gum and other caked materials should be removed. When floors are heavily soiled, an agent stronger than neutral soap may be required; however, use of soaps or detergents with a pH greater than 12.0 should be avoided.

When floors are being damp mopped, the mop should be dipped in neutral soap or mild detergent solution, wrung almost dry, and applied in long sweeping strokes. The mop should then be dipped in a bucket of clear water, wrung almost dry, and applied to the same area in similar fashion. It is not usually necessary to dry a damp mopped floor.

When a floor is being wet mopped, little water should be used along baseboards. Large areas of concrete, tile, and terrazzo floors may be scrubbed at a single time before rinsing, but other floors should be scrubbed in small portions. For cleaning tile floors, 2 to 8 ounces of neutral soap or cleaner (depending on the extent of the soil on the floor) should be used for each gallon of tepid water.

5. Walls

a. Exterior walls

Exterior walls should be inspected annually and repaired to keep them free from cracks and holes. Since caulking compounds containing an oil base tend to decompose on brick or masonry walls, such walls should be repainted rather than caulked. Waterproofing of exterior walls may be done after they are well painted and free from cracks. Exterior wooden walls should be painted at least every 3 or 4 years to maintain a good appearance and preserve the wood. Frequency of painting will depend upon atmospheric conditions, climate, and location. The care of exterior walls may be handled by contract, rather than routinely assigned to the custodian.

b. Interior walls (cleaning)

Interior walls should also be kept clean and free from holes and cracks. When washing painted walls manually, horizontal, or perpendicular, long strokes should be used. There are also wall-cleaning machines which operate on a vibrating principle which are effective in removing thick layers of dirt from painted wall surfaces. When concentrated trisodium phosphate cleaning compounds are used, a small area of wall should be cleaned at a time, then rinsed to remove deposits of the cleaning material. Different types of walls may be cleaned using a variety of techniques. For example, glazed tile, marble tile, or linoleum may be suitably cleaned with a damp cloth; strong cleaning solutions should not be used on such walls. After plaster walls are laid, they may be cleaned with water and a mild cleansing agent. There may be times when washing a wall may be more suitable than repainting; the opposite condition is also true. When smooth, untreated plaster walls are cleaned, a minimum of water should be used to avoid saturating the plaster.

c. Walls (painting)

A satisfactory method for freshening up a school environment and increasing the lighting of interior spaces is that of using paints. Following are some "do's" and "don'ts" of wall painting:

(1) Paint, lacquer, varnish or other surface coating containing lead should not be used on exposed interior or exterior surfaces in schools.

(2) Masonry walls should not be painted until they are cured and dry.

(3) Before painting over knots in wooden walls, knots should be coated first with shellac or a thin coat of aluminum powder.

(4) Blistered, cracked, and checked paint should be removed before repainting.

(5) Damp surfaces should be thoroughly dried before painting.

(6) An undercoat having a heavy oil base should be applied to fill cracks in fresh wood.

(7) Lithotone and titanium paints are satisfactory for exterior surfaces.

(8) Manufacturers' specifications should be followed in applying paints.

(9) Before varnishing, a coat of shellac should be applied and the surface buffed with steel wool.

(10) Before painting any plaster surface, all cracks should be filled with patching plaster and smoothed with fine sandpaper or steel wool. After this, a coat of primer-sealer should be applied and then two or more coats of paint.

(11) A light tone, multi-colored scheme should be used in school rooms. Select colors which will be harmonious and proportion them so the brightness of the room will be in balance (see Chapter 9, Illumination).

6. Windows and Doors

The outside surface of windows should be washed three or four times each year and inside window surfaces as often as once a month or more frequently as required. Glass surfaces in doors and cases may require weekly washing. Keeping windows clean yields dividends, as dirty windows reduce light by as much as 15 to 50 percent. A tablespoon of trisodium phosphate plus a little ammonia in one bucket (10 quarts) of clean water is a good cleaning solution. Commercial window cleaners may also be used.

Cloth window shades can be cleaned with a neutral soap solution. After cleaning they should be rinsed and dried. Venetian blinds should be vacuumed and, if required, cleaned with a damp cloth dipped in a solution of tetrasodium phosphate. Regular venetian blind brushes are available for dusting these. Another method for cleaning venetian blinds is soaking them for about an hour in a warm water bath containing detergent and bleach, followed by a thorough rinse.

7. Chalkboards

Chalkboards which are available in various colors are constructed of black slate, metal, plastics, tempered glass, and composition board. The amount of cleaning needed depends upon the type of chalkboard and how much it has been used. In spite of erasures, some boards should be cleaned once a day or more often. Some of the newer type chalkboards require cleaning by dry methods only. Manufacturers' specifications for cleaning chalkboards should be followed. Oil, caustic soda, and kerosene should not be used, and care should be exercised in the selection of cleaners and cloths to make certain they will not damage the chalkboard surface. When a chalkboard is washed, it should be washed from the top down with a damp cloth moistened in clear water without soap. The operation should cover about 2 square feet at a time; the board should then be dried with a dry cloth. Air-drying of chalkboards often produces streaks. Chalkboard troughs should be cleaned daily.

8. Erasers

Under ordinary conditions of use, erasers should be cleaned once or twice per week. In the absence of an electric cleaner, good results may be obtained by beating or rubbing the erasers together, or by use of a stiff brush.

9. Furniture and Woodwork

Furniture and woodwork should be dusted daily. Once or twice a year, these surfaces should be polished with cheesecloth, cotton, or wool cloth and a furniture polish. Floor oils or strong soaps should not be used. If soap is required, a neutral one should be used. Wax may also be effective in maintaining a good surface. When woodwork is being cleaned, warm water may be used to remove body grease and dirt.

10. Care of Grounds

The custodian's duties of maintaining the school plant in a satisfactory and pleasing condition also extend to the care of the grounds. In the event the custodial force is small, it may be necessary to hire additional labor, or by contract arrange for mowing lawns, trimming shrubbery, and policing or removing waste materials from the school grounds.

All naturally occurring accident hazards such as holes or gullies should be eliminated by filling; and the site kept free from glass, cans, or other objects that may cause injuries. Properly maintained lawns, flower patches, or plots about the school building enhance the appearance of the school plant. School pride does much to prevent school grounds from being littered and vandalized.

APPENDIX A
State Guidelines and Regulations

State	Title of Guide	Year Published
Alabama	*A Guide to Campus Improvement and Beautification* Mobile County Public Schools	1975
	Procedures and Design Criteria for the Preparation and Submission of Plans and Specifications on Sewage Treatment and Disposal, Water Supply and Food Service for Schools and Other Establishments Alabama State Department of Public Health	1969
Alaska		
Arizona		
Arkansas	*Guidelines for Planning School Facilities* Arkansas Department of Education	1975
California	*Profile Rating Wheel: An Instrument to Evaluate School Facilities* California State Department of Education	1973
Colorado		
Connecticut	*Fire Safety and Prevention Guide for Laboratories* Connecticut State Department of Education	1973
	The Public Health Code of the State of Connecticut and Other Department Regulations Connecticut State Department of Health	1974
Delaware		
Florida	*Educational Facilities Construction, Parts I, II, and III* Florida State Board of Education	1975
Georgia		
Hawaii		
Idaho	*Manual for School Building Planning, State of Idaho* Department of Education	1972
Illinois	*Efficient and Adequate Standards for the Construction of Schools* Office of the Superintendent of Public Instruction, State of Illinois	1969
	Building Specifications for Health and Safety in Public Schools Office of the Superintendent	1969

Indiana	*Suggested School Health Policies* State Department of Public Instruction and Indiana State Board of Health	1966
Iowa	*Recommended Guidelines for Sites, Facilities, and Equipment* State of Iowa, Department of Public Instruction	1974
Kansas	*Planning the School Building for Health and Safety* Kansas State Department of Health - Kansas State Department of Public Instruction	1967
	The School Inspector's Vade Mecum Kansas State Board of Health	1958
Kentucky	*State Board of Education Regulations* Department of Education	1975
Louisiana	*Sanitary Code, Chapter XV, Schools* Louisiana Health and Human Resources Administration	1974
	Planning Better Schools for Louisiana Louisiana State Department of Education	1975
Maine	*Guide and Standards for Planning School Buildings in Maine* State of Maine, Department of Education	1970
Maryland	*Administrative Procedures Guide: Public School Construction Program* State of Maryland	1973
Massachusetts		
Michigan	*School Plant Planning Handbook* Michigan Department of Education	1975
Minnesota	*Guide for Educational Planning of School Buildings and Sites in Minnesota* State of Minnesota, Department of Education	1971
Mississippi		
Missouri	*Regulations and Code Governing Sanitation of Schools* Missouri Division of Health	1948
Montana	*School Environment: Guide, Law and Regulations* Montana State Board of Health	1963
Nebraska	*Health Services in Nebraska Schools* Nebraska Committee for Children and Youth	1975
	Procedures for School Plant Planning State Board of Education	
Nevada		
New Hampshire	*Manual for Planning and Construction of School Buildings* State Department of Education	1975
New Jersey	*Guide for Schoolhouse Planning and Construction* State of N.J. Department of Education	1969

New Mexico		
New York	*Thermal Environment of Educational Facilities* Syracuse University Research Institute	1969
	Regulations of the Commissioner of Education State Education Department	1975
	Manual of Planning Standards: Educational Facilities State Education Department	1975
	Acoustics and Educational Facilities State Education Department	1966
North Carolina	*N.C. School Food Service Sanitation Manual* State Department of Public Instruction	1966
	The School Site: Land for Learning N.C. Department of Public Instruction	1975
North Dakota	*Manual for North Dakota School Buildings* Department of Public Instruction	1956
Ohio	*Sanitation in the School Environment* Ohio Department of Health	
Oklahoma		
Oregon		
Pennsylvania	*School Plant Guide* Department of Education	1970
Rhode Island	*Rules and Regulations for School Health Programs* Department of Health and Department of Education	1974
South Carolina	*S.C. School Facilities Planning and Construction Guide* State Department of Education	1969
	Guidelines for Planning Educational Facilities to Make Them Accessible to and Usable by, the Physically Handicapped Department of Public Health	
South Dakota		
Tennessee	*School Sanitation Program* Tennessee Department of Public Health	1969
	Rules, Regulations, and Minimum Standards Tennessee State Board of Education	1974
Texas	*Preliminary Guide for Planning a Secondary School Building Program* Texas Education Agency	1969
	Preliminary Guide for Planning an Elementary School Building Program Texas Education Agency	1966
Utah	*School Sanitation Regulations* Utah State Board of Health	1956
Vermont	*Planning Educational Environments* State of Vermont, Department of Education	1972

Virginia	*Environmental Education Guide K-12* State Department of Education	1974
Washington	*Rules and Regulations of the State Board of Health Chapters 248-64* Primary and Secondary Schools	1973
West Virginia	*State Department of Health Policies and Procedures* School Construction and Plan Review	1974
	Handbook on Planning School Facilities W.Va. Board of Education	1973
Wisconsin		
Wyoming	*Minimum Standards for the Sanitary Environment of Schools in Wyoming* Wyoming Department of Public Health	1962
District of Columbia	*Annual Report: Environmental Health Evaluation of the D.C. Public Schools* The Environmental Health Administration, Department of Environmental Services	1975

APPENDIX B

Recommendations Concerning Design of Buildings for Energy Savings

NEW FACILITIES

1. Do not sacrifice long-term maximum gains for short-term minimal savings.
2. Orient the building to take advantage of the natural energy saving features of the site - use trees and other buildings as windbreaks from, the winter prevailing winds and storms. Place parking areas so that they do not expose building to winter winds nor raise the temperature of cooling summer breezes.
3. Shape the building for optimum energy use. (Cubic shape maximizes volume while minimizing surface area.)
4. Design the facility on the edge of comfort, use humidity controls and good vapor barriers.
5. Consider burying part of the building to reduce heat losses and air infiltration.
6. Design the building for minimum acceptable exposed wall and roof areas.
7. Use sun to heat the building with south facing windows, and provide thermal curtains or shades during nighttime use, wind and nighttime ventilation to cool.
8. Supervision during building construction is essential to insure best use of building materials. Insure that vapor barriers and insulation are installed correctly.
9. Provide proper automatic controls - heat, ventilation, and for some lighting. Make use of natural ventilation when available, exhaust air to leeward direction.
10. Design efficient mechanical systems to cut down overheating and overlighting.
11. Use efficient lighting sources - concentrate light on tasks.
12. Room switching should be designed so unneeded rows of lights can be turned off. (New fixtures provide means to illuminate only a partial number of tubes.)
13. Require day/night thermostat control for unoccupied temperature setback.
14. The building gross wall should have a heat loss factor not greater than .20.

    a. The glass area of the wall should not exceed 20 percent of the total wall area.
    b. Windows generally should be double glazed, thermopane, or a combination, with nighttime insulating curtain or panel.
    c. Locate windows advantageously.
    d. Storm doors and/or vestibules should be used.
15. The building roof, through proper insulation, should have a heat loss factor no greater than .05; for opaque walls the heat factor should be no greater than .06; and foundation walls below grade enclosing a heated space should not be greater than 1.2. Floors to unheated spaces heat loss factor should be .08 or less.
16. The heating system efficiency should drop no more than 10 percent at 1/2 load.
17. Heating duct air losses should be restricted to 3 percent of air volume.
18. Hot water and steam lines should be insulated. Install low volume toilet fixtures and shower heads.
19. Restrict ventilation to **3 cubic feet** of air per person per minute when outside temperature is **below 10 degrees** F.
20. Large building heating zones involving multiple rooms should be restricted to 3,000 square feet or less. Heating systems should be able to function without introducing outside air.
21. Consider use of heat recovery systems that

remove heat from the exhaust air to preheat incoming air.

These recommendations were taken from the following sources:

a. Bureau of Public Improvements
b. Educational Facilities Laboratories, Inc. booklet "Economy of Energy Conservation in Educational Facilities"
c. *Nation's Schools* magazine, July 1974 issue.

EXISTING BUILDINGS

Much can be done to make existing buildings more efficient, thereby conserving energy and at the same time reducing the operational costs of the plant. A good conservation program begins with a thorough understanding of the school's mechanical systems: Heating, ventilation, air conditioning, plumbing, and electrical. This is essential for buildings already being used in the district and can be evaluated by appropriate officials in the system with the aid of engineers, especially those who design the mechanical systems. For a long-range program it is recommended that districts enlist the services of a reputable consulting engineer specializing in energy-saving methods.

The following recommendations are given to aid school boards and administrators in reducing the amount of energy used in their districts:

a. Plan an on-going energy conservation program for the district.
b. Develop training programs for operational and maintenance personnel. Have working drawings of the energy systems available for maintenance personnel.
c. Monitor energy and training programs continually, especially with regard to efficiency of mechanical systems.
d. If necessary, have a service control contract to repair, recalibrate, and adjust inoperative or ineffective controls.
e. Convert to modern, efficient equipment when aged equipment is found to be inefficient.
f. If possible, insulate above the ceilings of a building, as well as heat lines and ducts. This should be done on advice of competent engineers.
g. Consider installing storm windows, doors, outside vestibules, etc. Replace broken windows.
h. Switch rows of lighting so all fixtures do not have to be on, unless necessary.
i. Concentrate higher light levels only on tasks where needed.
j. Investigate possible ways to recover wasted heat through such techniques as heat pumps, exhaust heat recovery, etc.
k. Install efficient means to control the intake of outside air, especially in cold temperatures.
l. Seal cracks around exterior doors and windows as well as masonry joints, to reduce air infiltration. Plant trees or construct wind barriers against the prevailing winter and storm winds.
m. Repair all leaks or breaks in water lines. Install orifice plates in shower heads to reduce hot water consumption.

Energy conservation can be achieved in schools without compromise to the learning environment. It can be profitable both in prolonging our sources of energy and in reducing the overall operating expenses of the school.

It will take the combined efforts of all those involved, from planners, engineers, State regulatory personnel, and manufacturers to superintendents and school boards to achieve a sensible and worthwhile program. The time to begin these efforts is past - those who have not done so should begin today.

APPENDIX C[*]

American National Standard Specifications for Making Buildings and Facilities Accessible to, and Usable by, the Physically Handicapped

1. SCOPE AND PURPOSE

1.1 Scope

1.1.1 This standard applies to all buildings and facilities used by the public. It applies to temporary or emergency conditions as well as permanent conditions. It does not apply to private residences.

1.1.2 This standard is concerned with non-ambulatory disabilities, semi-ambulatory disabilities, sight disabilities, hearing disabilities, disabilities of incoordination, and aging.[1]

1.2 Purpose. This standard is intended to make all buildings and facilities used by the public accessible to, and functional for, the physically handicapped, to, through, and within their doors, without loss of function, space, or facility where the general public is concerned. It supplements existing American Standards, and reflects great concern for safety of life and limb. In cases of practical difficulty, unnecessary hardship, or extreme differences, administrative authorities may grant exceptions from the literal requirements of this standard or permit the use of other methods or materials, but only when it is clearly evident that equivalent facilitation and protection are thereby secured.

2. DEFINITIONS

2.1 Non-ambulatory Disabilities. Impairments that, regardless of cause or manifestation, for all practical purposes, confine individuals to wheelchairs.

2.2 Semi-ambulatory Disabilities. Impairments that cause individuals to walk with difficulty or insecurity. Individuals using braces or crutches, amputees, arthritics, spastics, and those with pulmonary and cardiac ills may be semi-ambulatory.

2.3 Sight Disabilities. Total blindness or impairments affecting sight to the extent that the individual functioning in public areas is insecure or exposed to danger.

2.4 Hearing Disabilities. Deafness or hearing handicaps that might make an individual insecure in public areas because he is unable to communicate or hear warning signals.

2.5 Disabilities of Incoordination. Faulty coordination or palsy from brain, spinal, or peripheral nerve injury.

2.6 Aging. Those manifestations of the aging processes that significantly reduce mobility, flexibility, coordination, and perceptiveness but are not accounted for in the aforementioned categories.

2.7 Standard. When this term appears in small letters and is not preceded by the word "American," it is descriptive and does not refer to an American Standard approved by ASA; for example, a "standard" wheelchair is one characterized as standard by the manufacturers.

2.8 Fixed Turning Radius, Wheel to Wheel. The tracking of the caster wheels and large wheels of a wheelchair when pivoting on a spot.

2.9 Fixed Turning Radius, Front Structure to Rear Structure. The turning radius of a wheelchair, left front-foot platform to right rear

[1] See definitions in Section 2.

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wheel, or right front-foot platform to left rear wheel, when pivoting on a spot.

2.10 Involved (Involvement). A portion or portions of the human anatomy or physiology, or both, that have a loss or impairment of normal function as a result of genesis, trauma, disease, inflammation, or degeneration.

2.11 Ramps, Ramps with Gradients. Because the term "ramp" has a multitude of meanings and uses, its use in this text is clearly defined as ramps with gradients (or ramps with slopes) that deviate from what would otherwise be considered the normal level. An exterior ramp, as distinguished from a "walk," would be considered an appendage to a building leading to a level above or below existing ground level. As such, a ramp shall meet certain requirements similar to those imposed upon stairs.

2.12 Walk, Walks. Because the terms "walk" and "walks" have a multitude of meanings and uses, their use in this text is clearly defined as a predetermined, prepared-surface, exterior pathway leading to or from a building or facility, or from one exterior area to another, placed on the existing ground level and not deviating from the level of the existing ground immediately adjacent.

2.13 Appropriate Number. As used in this text, appropriate number means the number of a specific item that would be necessary, in accord with the purpose and function of a building or facility, to accomodate individuals with specific disabilities in proportion to the anticipated number of individuals with disabilities who would use a particular building or facility.

EXAMPLE: Although these specifications shall apply to all buildings and facilities used by the public, the numerical need for a specific item would differ, for example, between a major transportation terminal, where many individuals with diverse disabilities would be continually coming and going, an office building or factory, where varying numbers of individuals with disabilities of varying manifestations (in many instances, very large numbers) might be employed or have reason for frequent visits, a school or church, where the number of individuals may be fixed and activities more definitive, and the many other buildings and facilities dedicated to specific functions and purposes.

NOTE: Disabilities are specific and where the individual has been properly evaluated and properly oriented and where architectural barriers have been eliminated, a specific disability does not constitute a handicap. It should be emphasized that more and more of those physically disabled are becoming *participants*, rather than spectators, in the fullest meaning of the word.

3. GENERAL PRINCIPLES AND CONSIDERATIONS

3.1 Wheelchair Specifications. The collapsible-model wheelchair of tubular metal construction with plastic upholstery for back and seat is most commonly used. The standard model of all manufacturers falls within the following limits, which were used as the basis of consideration:

(1) Length: 42 inches
(2) Width, when open: 25 inches
(3) Height of seat from floor: 19½ inches
(4) Height of armrest from floor: 29 inches
(5) Height of pusher handles (rear) from floor: 36 inches
(6) Width, when collapsed: 11 inches

3.2 The Functioning of a Wheelchair

3.2.1 The fixed turning radius of a standard wheelchair, wheel to wheel, is 18 inches. The fixed turning radius, front structure to rear structure, is 31.5 inches.

3.2.2 The average turning space required (180 and 360 degrees) is 60 × 60 inches.

NOTE: Actually, a turning space that is longer than it is wide, specifically, 63 × 56 inches, is more workable and desirable. In an area with two open ends, such as might be the case in a corridor, a minimum of 54 inches between two walls would permit a 360-degree turn.

3.2.3 A minimum width of 60 inches is required for two individuals in wheelchairs to pass each other.

3.3 The Adult Individual Functioning in a Wheelchair[2]

3.3.1 The average unilateral vertical reach is 60 inches and ranges from 54 inches to 78 inches.

3.3.2 The average horizontal working (table) reach is 30.8 inches and ranges from 28.5 inches to 33.2 inches.

3.3.3 The bilateral horizontal reach, both arms extended to each side, shoulder high, ranges from 54 inches to 71 inches and averages 64.5 inches.

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[2] Extremely small, large, strong, or weak and involved individuals could fall outside the ranges in 3.3.1, 3.3.2, 3.3.3, and their reach could differ from the figure given in 3.3.4. However, these reaches were determined using a large number of individuals who were functionally trained, with a wide range in individual size and involvement.

3.3.4 An individual reaching diagonally, as would be required in using a wall-mounted dial telephone or towel dispenser, would make the average reach (on the wall) 48 inches from the floor.

3.4 The Individual Functioning on Crutches[3]

3.4.1 On the average, individuals 5 feet 6 inches tall require an average of 31 inches between crutch tips in the normally accepted gaits.[4]

3.4.2 On the average, individuals 6 feet 0 inches tall require an average of 32.5 inches between crutch tips in the normally accepted gaits.[4]

4. SITE DEVELOPMENT[5]

4.1 Grading. The grading of ground,even contrary to existing topography, so that it attains a level with a normal entrance will make a facility accessible to individuals with physical disabilities.

4.2 Walks

4.2.1 Public walks should be at least 48 inches wide and should have a gradient not greater than 5 percent.[6]

4.2.2 Such walks shall be of a continuing common surface, not interrupted by steps or abrupt changes in level.

NOTE: 4.1 and 4.2, separately or collectively, are greatly aided by terracing, retaining walls, and winding walks allowing for more gradual incline, thereby making almost any building accessible to individuals with permanent physical disabilities, while contributing to its esthetic qualities.

4.2.3 Wherever walks cross other walks, driveways, or parking lots they should blend to a common level.[7]

4.2.4 A walk shall have a level platform at the top which is at least 5 feet by 5 feet, if a door swings out onto the platform or toward the walk. This platform shall extend at least 1 foot beyond each side of the doorway.

4.2.5 A walk shall have a level platform at least 3 feet deep and 5 feet wide, if the door does not swing onto the platform or toward the walk. This platform shall extend at least 1 foot beyond each side of the doorway.

4.3 Parking Lots

4.3.1 Spaces that are accessible and approximate to the facility should be set aside and identified for use by individuals with physical disabilities.

4.3.2 A parking space open on one side, allowing room for individuals in wheelchairs or individuals on braces and crutches to get in and out of an automobile onto a level surface, suitable for wheeling and walking, is adequate.

4.3.3 Parking spaces for individuals with physical disabilities when placed between two conventional diagonal or head-on parking spaces should be 12 feet wide.

4.3.4 Care in planning should be exercised so that individuals in wheelchairs and individuals using braces and crutches are not compelled to wheel or walk behind parked cars.

4.3.5 Consideration should be given the distribution of spaces for use by the disabled in accordance with the frequency and persistency of parking needs.

4.3.6 Walks shall be in conformity with 4.2.

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[3] Most individuals ambulating on braces or crutches, or both, or on canes are able to manipulate within the specifications prescribed for wheelchairs, although doors present quite a problem at times. However, attention is called to the fact that a crutch tip extending laterally from an individual is not obvious to others in heavily trafficked areas, certainly not as obvious or protective as a wheelchair and is, therefore, a source of vulnerability.

[4] Some cerebral palsied individuals, and some severe arthritics, would be extreme exceptions to 3.4.1 and 3.4.2.

[5] Site development is the most effective means to resolve the problems created by topography, definitive architectural designs or concepts, water table, existing streets, and atypical problems, singularly or collectively, so that aggress, ingress, and egress to buildings by physically disabled can be facilitated while preserving the desired design and effect of the architecture.

[6] It is essential that the gradient of walks and driveways be less than that prescribed for ramps, since walks would be void of handrails and curbs and would be considerably longer and more vulnerable to the elements. Walks of near maximum grade and considerable length should have level areas at intervals for purposes of rest and safety. Walks or driveways should have a nonslip surface.

[7] This specification does not require the elimination of curbs, which, particularly if they occur at regular intersections, are a distinct safety feature for all of the handicapped, particularly the blind. The preferred method of meeting the specification is to have the walk incline to the level of the street. However, at principal intersections, it is vitally important that the curb run parallel to the street, up to the point where the walk is inclined, at which point the curb would turn in and gradually meet the level of the walk at its highest point. A less preferred method would be to gradually bring the surface of the driveway or street to the level of the walk. The disadvantage of this method is that a blind person would not know when he has left the protection of a walk and entered the hazards of a street or driveway.

5. BUILDINGS

5.1 Ramps with Gradients. Where ramps with gradients are necessary or desired, they shall conform to the following specifications:

5.1.1 A ramp shall not have a slope greater than 1 foot rise in 12 feet, or 8.33 percent, or 4 degrees 50 minutes.

5.1.2 A ramp shall have handrails on at least one side, and preferably two sides, that are 32 inches in height, measured from the surface of the ramp, that are smooth, that extend 1 foot beyond the top and bottom of the ramp, and that otherwise conform with American Standard Safety Code for Floor and Wall Openings, Railings, and Toe Boards, A12.1-1973.

NOTE 1: Where codes specify handrails to be of heights other than 32 inches, it is recommended that two sets of handrails be installed to serve all people. Where major traffic is predominantly children, particularly physically disabled children, extra care should be exercised in the placement of handrails, in accordance with the nature of the facility and the age group or groups being serviced.

NOTE 2: Care should be taken that the extension of the handrail is not in itself a hazard. The extension may be made on the side of a continuing wall.

5.1.3 A ramp shall have a surface that is nonslip.

5.1.4 A ramp shall have a level platform at the top which is at least 5 feet by 5 feet, if a door swings out onto the platform or toward the ramp. This platform shall extend at least 1 foot beyond each side of the doorway.

5.1.5 A ramp shall have a level platform at least 3 feet deep and 5 feet wide, if the door does not swing onto the platform or toward the ramp. This platform shall extend at least 1 foot beyond each side of the doorway.

5.1.6 Each ramp shall have at least 6 feet of straight clearance at the bottom.

5.1.7 Ramps shall have level platforms at 30-foot intervals for purposes of rest and safety and shall have level platforms wherever they turn.

5.2 Entrances

5.2.1 At least one primary entrance to each building shall be usable by individuals in wheelchairs.

NOTE: Because entrances also serve as exits, some being particularly important in case of an emergency, and because the proximity of such exits to all parts of buildings and facilities, in accordance with their design and function, is essential (see 112 and 2000 through 2031 of American Standard Code for Safety to Life from Fire in Buildings and Structures, A9.1-1974) it is preferable that all or most entrances (exits) should be accessible to, and usable by, individuals in wheelchairs and individuals with other forms of physical disability herein applicable.

5.2.2 At least one entrance usable by individuals in wheelchairs shall be on a level that would make the elevators accessible.

5.3 Doors and Doorways

5.3.1 Doors shall have a clear opening of no less than 32 inches when open and shall be operable by a single effort.

NOTE 1: Two-leaf doors are not usable by those with disabilities defined in 2.1, 2.2, and 2.5 unless they operate by a single effort, or unless one of the two leaves meets the requirement of 5.3.1.

NOTE 2: It is recommended that all doors have kick plates extending from the bottom of the door to at least 16 inches from the floor, or be made of a material and finish that would safely withstand the abuse they might receive from canes, crutches, wheelchair foot-platforms, or wheelchair wheels.

5.3.2 The floor on the inside and outside of each doorway shall be level for a distance of 5 feet from the door in the direction the door swings and shall extend 1 foot beyond each side of the door.

5.3.3 Sharp inclines and abrupt changes in level shall be avoided at doorsills. As much as possible, thresholds shall be flush with the floor.

NOTE 1: Care should be taken in the selection, placement, and setting of door closers so that they do not prevent the use of doors by the physically disabled. Time-delay door closers are recommended.

NOTE 2: Automatic doors that otherwise conform to 5.3.1, 5.3.2, and 5.3.3 are very satisfactory.

NOTE 3: These specifications apply both to exterior and interior doors and doorways.

5.4 Stairs. Stairs shall conform to American Standard Code for Safety to Life from Fire in Buildings and Structures, A9.1-1974, with the following additional considerations:

5.4.1 Steps in stairs that might require use by those with disabilities defined in 2.2 and 2.5 or by the aged shall not have abrupt (square) nosing. (See Fig. 1.)

NOTE: Individuals with restrictions in the knee, ankle, or hip, with artificial legs, long leg braces, or comparable conditions cannot, without great difficulty and hazard, use steps with nosing as illustrated in Fig. 1a, but can safely and with minimum difficulty use steps with nosing as illustrated in Fig. 1b.

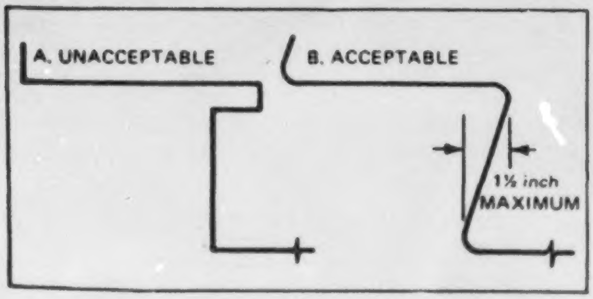

FIGURE 1. Steps.

5.4.2 Stairs shall have handrails 32 inches high as measured from the tread at the face of the riser.

NOTE: Where codes specify handrails to be at heights other than 32 inches, it is recommended that two sets of handrails be installed to serve all people. Where traffic is predominantly children, particularly physically disabled children, extra care should be exercised in the placement of handrails in accordance with the nature of the facility and the age group or groups being serviced. Dual handrails may be necessary.

5.4.3 Stairs shall have at least one handrail that extends at least 18 inches beyond the top step and beyond the bottom step.

NOTE: Care should be taken that the extension of the handrails is not in itself a hazard. The extension may be made on the side of a continuing wall.

5.4.4 Steps should, wherever possible, and in conformation with existing step formulas, have risers that do not exceed 7 inches.

5.5 Floors

5.5.1 Floors shall have a surface that is nonslip.

5.5.2 Floors on a given story shall be of a common level throughout or be connected by a ramp in accord with 5.1.1 through 5.1.6, inclusive.

EXAMPLE 1: There shall not be a difference between the level of the floor of a corridor and the level of the floor of the toilet rooms.

EXAMPLE 2: There should not be a difference between the level of the floor of a corridor and the level of a meeting room, dining room, or any other room, unless proper ramps are provided.

5.6 Toilet Rooms. It is essential that an appropriate number[8] of toilet rooms, in accordance with the nature and use of a specific building or facility, be made accessible to, and usable by, the physically handicapped.

5.6.1 Toilet rooms shall have space to allow traffic of individuals in wheelchairs, in accordance with 3.1, 3.2, and 3.3.

5.6.2 Toilet rooms shall have at least one toilet stall that—

(1) Is 3 feet wide

(2) Is at least 4 feet 8 inches, preferably 5 feet, deep

(3) Has a door (where doors are used) that is 32 inches wide and swings out

(4) Has handrails on each side, 33 inches high and parallel to the floor, 1½ inches in outside diameter, with 1½ inches clearance between rail and wall, and fastened securely at ends and center

(5) Has a water closet with the seat 20 inches from the floor

NOTE: The design and mounting of the water closet is of considerable importance. A wall-mounted water closet with a narrow understructure that recedes sharply is most desirable. If a floor-mounted water closet must be used, it should not have a front that is wide and perpendicular to the floor at the front of the seat. The bowl should be shallow at the front of the seat and turn backward more than downward to allow the individual in a wheelchair to get close to the water closet with the seat of the wheelchair.

5.6.3 Toilet rooms shall have lavatories with narrow aprons, which when mounted at standard height are usable by individuals in wheelchairs; or shall have lavatories mounted higher, when particular designs demand, so that they are usable by individuals in wheelchairs.

NOTE: It is important that drain pipes and hot-water pipes under a lavatory be covered or insulated so that a wheelchair individual without sensation will not burn himself.

5.6.4 Some mirrors and shelves shall be provided above lavatories at a height as low as possible and no higher than 40 inches above the floor, measured from the top of the shelf and the bottom of the mirror.

5.6.5 Toilet rooms for men shall have wall-mounted urinals with the opening of the basin 19 inches from the floor, or shall have floor-mounted urinals that are on level with the main floor of the toilet room.

5.6.6 Toilet rooms shall have an appropriate number[8] of towel racks, towel dispensers, and other dispensers and disposal units mounted no higher than 40 inches from the floor.

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[8] See 2.13.

5.7 Water Fountains. An appropriate number[8] of water fountains or other water-dispensing means shall be accessible to, and usable by, the physically disabled.

5.7.1 Water fountains or coolers shall have up-front spouts and controls.

5.7.2 Water fountains or coolers shall be hand-operated or hand- and foot-operated. (See also American Standard Specifications for Drinking Fountains, and Self-Contained Mechanically-Refrigerated Drinking-Water Coolers, A 112.11.1-1973.)

NOTE 1: Conventional floor-mounted water coolers can be serviceable to individuals in wheelchairs if a small fountain is mounted on the side of the cooler 30 inches above the floor.

NOTE 2: Wall-mounted, hand-operated coolers of the latest design, manufactured by many companies, can serve the able-bodied and the physically disabled equally well when the cooler is mounted with the basin 36 inches from the floor.

NOTE 3: Fully recessed water fountains are not recommended.

NOTE 4: Water fountains should not be set into an alcove unless the alcove is wider than a wheelchair. (See 3.1.)

5.8 Public Telephones. An appropriate number[8] of public telephones should be made accessible to, and usable by, the physically disabled.

NOTE: The conventional public telephone booth is not usable by most physically disabled individuals. There are many ways in which public telephones can be made accessible and usable. It is recommended that architects and builders confer with the telephone company in the planning of the building or facility.

5.8.1 Such telephones should be placed so that the dial and the handset can be reached by individuals in wheelchairs, in accordance with 3.3.

5.8.2 An appropriate number[8] of public telephones should be equipped for those with hearing disabilities and so identified with instructions for use.

NOTE: Such telephones can be used by everyone.

5.9 Elevators. In a multiple-story building, elevators are essential to the successful functioning of physically disabled individuals. They shall conform to the following requirements:

5.9.1 Elevators shall be accessible to, and usable by, the physically disabled on the level that they use to enter the building, and at all levels normally used by the general public.

5.9.2 Elevators shall allow for traffic by wheelchairs, in accordance with 3.1, 3.2, 3.3 and 5.3.

5.10 Controls. Switches and controls for light, heat, ventilation, windows, draperies, fire alarms, and all similar controls of frequent or essential use, shall be placed within the reach of individuals in wheelchairs. (See 3.3.)

5.11 Identification. Appropriate identification of specific facilities within a building used by the public is particularly essential to the blind.

5.11.1 Raised letters or numbers shall be used to identify rooms or offices.

5.11.2 Such identification should be placed on the wall, to the right or left of the door, at a height between 4 feet 6 inches and 5 feet 6 inches, measured from the floor, and preferably at 5 feet.

5.11.3 Doors that are not intended for normal use, and that might prove dangerous if a blind person were to exit or enter by them, should be made quickly identifiable to the touch by knurling the door handle or knob. (See Fig. 2.)

EXAMPLE: Such doors might lead to loading platforms, boiler rooms, stages, fire escapes, etc.

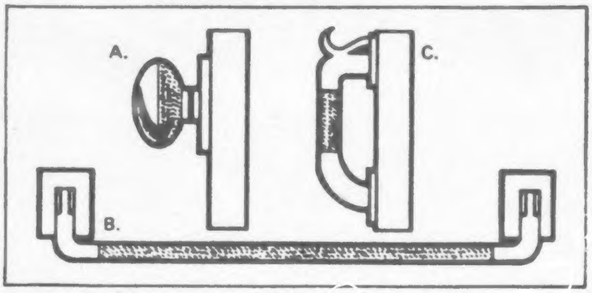

FIGURE 2. Door Handles and Knobs.

5.12 Warning Signals

5.12.1 Audible warning signals shall be accompanied by simultaneous visual signals for the benefit of those with hearing disabilities.

5.12.2 Visual signals shall be accompanied by simultaneous audible signals for the benefit of the blind.

5.13 Hazards. Every effort shall be exercised to obviate hazards to individuals with physical disabilities.

5.13.1 Access panels or manholes in floors, walks, and walls can be extremely hazardous, particularly when in use, and should be avoided.

5.13.2 When manholes or access panels are open and in use, or when an open excavation exists on a site, particularly when it is approximate to normal pedestrian traffic, barricades shall be placed on all open sides at least 8 feet from the hazard, and warning devices shall be installed in accord with 5.12.2.

5.13.3 Low-hanging door closers that remain within the opening of a doorway when the door is open, or that protrude hazardously into regular corridors or traffic ways when the door is closed, shall be avoided.

5.13.4 Low-hanging signs, ceiling lights, and similar objects or signs and fixtures that protrude into regular corridors or traffic ways shall be avoided. A minimum height of 7 feet, measured from the floor, is recommended.

5.13.5 Lighting on ramps shall be in accord with 1201, 1202, 1203, and 1204 of American Standard Code for Safety to Life from Fire in Buildings and Structures, A 9.1-1974.

5.13.6 Exit signs shall be in accord with 1205 of American Standard Code for Safety to Life from Fire in Buildings and Structures, A 9.1-1974, except as modified by 5.11 of this standard.

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